DEAF-MUTISM

HOLGER MYGIND

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DEAF-MUTISM.

BY

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LONDON:

F. J. REBMAN, 11, ADAM STREET, STRAND.

1894.

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PREFACE.

It has been the author's object to present to the public in the present work an exhaustive and systematically arranged description of deaf-mutism, considered as a pathological condition.

The materials made use of were furnished from existing literature and the author's own investigations, which latter are principally of anatomical and statistical character, and refer almost entirely to deaf-mutes in Denmark.

The author is deeply indebted to his friend, Dr. Norris Wolfenden (London), for his valuable assistance in the revision and publication of the English edition of this book, without which assistance its shortcomings as to language would have been too painfully evident. If any such are still noticeable, he would fain hope that readers will be lenient to such shortcomings, and bear in mind that the author is not an Englishman.

THE AUTHOR.

Copenhagen,
March, 1894.

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INTRODUCTION.

DEFINITION.—*Deaf-mutism*, strictly speaking, signifies the abnormality which is characterised by the co-existence of deafness and dumbness. Various circumstances, which will be treated of in the following pages, necessitate, however, a more limited definition. Deaf-mutism may, therefore, be defined as a pathological condition dependent upon an anomaly of the auditory organs, either congenital or acquired in early childhood, causing so considerable a diminution of the power of hearing as to prevent the acquisition of speech, or,—should speech have been acquired before the occurrence of the loss of hearing—as to prevent its preservation by the aid of hearing alone. Individuals exhibiting this pathological condition are described as *deaf-mutes*, even when speech has been acquired by a special system of instruction.

Theoretically, deaf-mutism is an ill-defined condition, which cannot be distinctly separated from other conditions related to it. This is a natural consequence of its being a pathological term founded, not only upon a symptom, deafness, but also upon the intensity of that symptom and the period of its occurrence. There is also an apparent contradiction in the fact that deaf-mutes include, not only those who cannot, but also those who can, hear, or speak. Practically, however, there is seldom any difficulty in determining whether an individual is or is not a deaf-mute, just as it is also, as a rule, easy to recognise deaf-mutism, when the individual in question has passed the first years of infancy. The reason is that the acquisition and preservation of speech in childhood is so dependent upon hearing, that so soon as the latter sinks below a certain degree, the former cannot be developed, or is lost, and this secondary dumbness does not easily escape observation. Occasionally, it may be difficult to decide whether a child should be described as a deaf-mute, or merely deficient in hearing and speech. Such cases must be decided by purely practical considerations, and it may not be out of the way to observe, that in Denmark, where the education of deaf-mutes is compulsory, all children are considered as deaf-mutes, who cannot, owing to their deficient hearing, take part in the instruction given to normal children.

LITERATURE.—Only such works as have treated more especially of the nature of deaf-mutism are mentioned in the following pages. An exception, however, has been made in favour of such ancient writings as contain passages tending to throw a light upon the opinions held in earlier times as to deaf-mutism.

ANTIQUITY.—Although deaf-mutism is doubtless coeval with humanity, ancient Greek and Roman authors have but little to say upon the subject.

Herodotus is the first author who mentions a deaf-mute.* He relates in 1st Book, chap. x., 34, that Croesus had two sons, one of whom was of but little account to him, being a deaf-mute † [1, p. 78 ‡] ; this deaf-mute—according to Herodotus —regained the power of speech.

Hippocrates states in his work *περὶ σαρκῶν* [2, sect. 18, p. 608], as a proof that the aid of the tongue is necessary for articulate speech, *οἱ κωφοὶ οἱ ἐκ γενετῆς οὐκ επίστανται διαλέγεσθαι* (*i.e.* deaf-mutes § do not know how to speak.) This would seem to indicate that Hippocrates considered deaf-mutism as the result of an inability to use the tongue, and that he did not recognize the dumbness as being the result of deafness. Hippocrates does not otherwise mention deaf-mutes.

Neither did Aristotle understand the connection between deafness and dumbness. In his work on the senses, he compares deaf-mutes with the blind, and comes to the conclusion that the blind are superior

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* Deaf-mutes are, however, spoken of in Exodus, chap. iv., 2.

† Herodotus makes use of the expression *κωφός*, which originally implied dumb, but which according to Ammonius by degrees included the idea of deafness. Deaf-mutes were also called *ἔνεοι* or *ἄφωνοι* or *ἄλαλοι*, *i.e.*, such as cannot speak. Herodotus was evidently aware that deaf-mutes cannot hear as he says of the son of Croesus in chap. 38, that he was *διεφθαρμένος τὴν ἀκοήν* (deprived of hearing).

‡ Here, and afterwards, the figures in brackets as above refer to the bibliography at the end of the book.

§ Properly speaking "deaf from birth," or "dumb from birth." It is difficult to decide which translation is correct (see above note). There is much which speaks in favour of Hippocrates as well as later authors having understood deaf-mutes pure and simple by κωφοί ἐκ γενετῆς. In Latin deaf-mutes, in general, are spoken of as *surdi nati*, which expression appears again in French, even Itard using the heading *surdité de la naissance* for deaf-mutism.

[3, sect. i., p. 437]. Aristotle seems to have arrived at this result upon the premise that deaf-mutes were not able to speak. This explanation is corroborated by the reply in his *ηροβλήματα* to the question why the deaf always speak through the nose. He says the reason is that they are almost deaf-mutes (*ἔνεοί*); "the latter breathe through the nose, since the passage through the mouth is blocked up by their not using their tongue for speaking" [5, Problem XL., sect. 2, p. 898]. It has been supposed that Aristotle was acquainted with the causal connection between deafness and dumbness, because he, in his work, *περὶ ζώων ἴστορίας* [4, p. 536], has said: *ὅσοι δε κωφοί γίγνονται ἐκ γενετῆς πάντες καὶ ἔνεοί γίγνονται* (which sentence reminds us of the above quotation from Hippocrates, and must be translated in the same manner). Aristotle has, however, only intended to convey that deafness and dumbness accompany each other. He states (Problem XXXIII., 1) that both lungs and ears are in connection with the brain, "which is evident, as deafness and dumbness accompany each other, and diseases of the ear act reciprocally with those of the lungs." [5, p. 899].

It is, therefore, the more remarkable that *Alexander of Aphrodisias*, a medical author not particularly well known, who lived in the third century after Christ, seems to have understood the relationship between deafness and dumbness. He rejects Aristotle's doctrine of a connection between the nerves of the ear and the organs of speech, and states in his *προβλήματα* I., 138, that it is the want of hearing which deprives the deaf-mute of the power of speech [9, p. 47].

Among Latin authors of antiquity deaf-mutism is only mentioned by PLINY THE ELDER and GELLIUS. PLINY speaks of the well-known case of the deaf boy, QUINTUS PEDIUS, whom the orator, MESSALA, caused to be instructed in painting [*naturalis historia, lib.* xxxv., *cap.* 4; *see* 7, vol. v., p. 112]. It is added that the Emperor AUGUSTUS approved of this action, which fact plainly proves how little was done for deaf-mutes in ancient times.*

PLINY states elsewhere [*lib.* x., *cap.* 69, 7, vol. ii., p. 158], *auditus cui hominum primo negatus est, huic et sermonis usus ablatus, nec sunt naturaliter surdi ut idem sint et muti* (the man who is born without the power of hearing is also deprived of the power of speech, and none are born deaf who are not also dumb). GELLIUS mentions an athlete from Samos who suddenly recovered the power of speech on seeing that the drawing of lots for a sacred combat was conducted unfairly [*noctes atticæ*, v., 9; *see* 8, vol. i., p. 301]. It seems, however, as if this case refers to a dumb person only.

THE MIDDLE AGES.—It is not to be wondered at, considering the influence ARISTOTLE exercised upon the middle ages, that his erroneous opinions concerning the nature of deaf-mutism held sway until comparatively modern times.

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* One of MARTIAL's epigrams contains the following:

Mulio viginti venit modo millibus, Aule.
Miraris pretium tam grave? Surdis erat.

This passage has often been quoted as a proof that deaf-mutes were employed in Rome for immoral purposes. It is, however, more natural to suppose that the high price paid for the mule driver in question was owing to his not being able to hear his passengers' conversation.

Cardanus, naturalist, mathematician and physician, who lived in Pavia and Bologna from 1501 to 1576, was the first to set forth distinctly the modern and correct opinion, that deafness is the principal and primary phenomenon in deaf-mutism. He expresses himself as follows in his treatise *de utilitate ex adversis capienda, lib. II., cap. 7, de surditate*: "There are three classes of deaf: Some are born deaf—of these it is not our intention to speak; they are also dumb, for as we learn to speak by hearing, those who cannot hear cannot speak [*nam cum discamus audiendo loqui, qui audire non possunt, nec loqui*]. Others become deaf after birth but before they learn to speak; they are dumb from the same cause as those above mentioned, and are therefore included and treated of in the same class." Cardanus ends by declaring that deaf-mutes ought, like the blind, to be taught to read and write, although a matter of difficulty; "but difficulties are useful, and still more honourable, although we may not attain our aim, for it is not everyone who reaches Corinth" [11, p. 73, and following].

A contemporary of Cardanus was the celebrated Benedictine monk, Pedro de Ponce, surnamed Venerabilis, who lived in Sagahun, in Spain. It is to him that the honour is due of having first proved practically that dumbness in deaf-mutism is a secondary condition resulting from deafness, and that it can be removed by a special system of education. Franciscus Valesius, Philip the Second's physician, relates the following of the famous monk. After having compared the power of speech and writing, and having come to the conclusion that it is not necessary for speech to precede writing, but that it does so as a rule because it is the easiest for those in full possession of their senses, he says: "That the opposite can be the case has been plainly proved by my friend, Petrus Pontius the Benedictine, as he—*mirabile dictu*—has taught the deaf-born to speak, without other art than by first teaching them to write by pointing out to them the objects which the characters expressed, and then causing them to make the movements with the tongue which correspond to the characters" [12, p. 53].*

In 1595, ten years after Pedro de Ponce's death, Andreas Laurentius states that the then-existing opinion was, that deaf-mutes were unable to speak because they could not hear, hearing being the organ of instruction [13, p. 430]. Aristotle's doctrine was, however, so deeply rooted, that Laurentius adds that he does not agree with the general opinion, and endeavours to find an explanation in a connection between the nerves of the tongue and ear. Incorrect ideas as to deaf-mutism were in existence not only during the following centuries [Zachias, *lib.* ii., *tit.* i., *quaest.* viii.; *see* 18, vol. i., p. 130], but even at the beginning of the present century [*see* ITARD, 31, vol ii., p. 452].

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* Pedro de Ponce has not, of course been allowed to enjoy the honour of being the discoverer of oral instruction undisputed. It has been said that Bishop John of Hagustald (Hexham), in Northumberland, was the first to teach a deaf-mute to speak (in the seventh century after Christ). From Bede's History it would seem that the person in question was only dumb (*mutus*), as nothing is said of his having been deaf [*lib.* v., *cap.* ii., sec. 10, p. 183]. The Spaniard, Juan Pablo Bonet, whose book, *Reduction de las letras, y arte para enseñas a hablos los mudos*, appeared in 1620, has been considered to be the discoverer of the system, as he does not mention Pedro de Ponce in his work. The Spanish monk, Benito Geronymo Feyoo, has subjected the question to a thorough investigation, and has come to the conclusion that Bonet, whose work bears evidence of great ability, was "*no sole plagiario mas un impostor*" [17, vol. iv., p. 86], as he had doubtless learnt the art from one of de Ponce's pupils, to the father of whom he was secretary.

THE NINETEENTH CENTURY.—Apart from numerous philosophical and especially pedagogal writings, no large work of importance on the more physical nature of deaf-mutism appeared until ITARD'S dissertation at the end of his manual on ear-diseases [31, vol. ii., p. 403–522]. ITARD entered especially into the question of the curability of deaf-mutism, and did much to elucidate other matters concerning its etiology and morbid anatomy.

Only the larger and more important works upon deaf-mutism which have appeared in the present century (the pedagogal and philosophical always excepted) will be mentioned here, readers being referred to the bibliography at the end of the book.

ED. SCHMALZ' work, "*Ueber die Taubstummen*" [70], appeared in 1838, and was followed, ten years later by a second edition. This contains statistical matter of great importance, also information as to the then-existing deaf and dumb institutions. The immediate and predisposing causes are also subjects of extensive consideration. The historical introduction is of great interest.

WILDE'S treatise on deaf-mutism at the end of his classical work on diseases of the ear [72, p. 436–496] is remarkable for its exhaustive historical survey, and for the account of the results yielded by the Irish census of 1851, and is a most valuable work.

In 1856 MEISSNER published his book, "*Taubstummheit und Taubstummenbildung* [76], in which the comprehensive bibliography is particularly worthy of mention.

Toynbee, who paid particular attention to the examination of deaf-mutes during life, and to post-mortem examinations of their organs of hearing, has a special chapter (chap. viii.) upon deaf-mutism in his eminent work on ear-diseases, published in 1860 [86]. This contains his numerous observations, and is of lasting value.

Finally, mention must be made of the following recent works on deaf-mutism: A. Hartmann's monograph, "*Taubstummheit und Taubstummenbildung*," published in 1880 [132], an excellent book, which is remarkable for its clearness and for the exhaustive use made of existing literature; Hedinger's treatise, published in 1882, the result of comprehensive and thorough examinations of deaf-mutes [144]; H. Schmaltz "*Die Taubstummen im Königreich Sachsen*" [161], an eminent work to which reference will often be made in the following pages; finally, Chr. Lemcke's "*Die Taubstummheit im Mecklenburg-Schwerin* [210], a most admirable work, the result of a personal examination of all deaf-mutes in Mecklenburg-Schwerin.

CLASSIFICATION.—Deaf-mutism can be classified (1) either according to the degree of its symptoms, or, (2) according to its etiology. In the first case a distinction must be made according as the deafness or dumbness is absolute or not. *True deaf-mutism* may be described as being the state in which the hearing is positively *nil*, and in which there is no power of speech, unless it be acquired by a special method of instruction. Individuals with this form of deafness may be designated *true deaf-mutes*. Those who have some slight power of hearing, or some power of speech (either because the hearing is not totally absent, or because the deafness occurred after speech had been acquired), may be described as *semi-mutes*.

Etiologically, deaf-mutism has been further divided into *endemic deaf-mutism*, *i.e.*, that which attaches to certain districts and their natural conditions; and *sporadic deaf-mutism*, which is the result of certain accidental causes. Both these forms may be congenital or acquired [Bircher, 158, p. 67]. No objection can be made to this mode of classification. There is, however, much which seems to prove that the endemic form of deaf-mutism common in Switzerland, and which is an expression of cretenic degeneration, is, both as regards etiology, morbid anatomy, and more particularly symptomatology different from that treated of in this work (*see* definition, p. i.). In support of this opinion, which was first expressed by Uchermann [203, p. 99], it may be stated that, according to Bircher, "numerous dumb persons in districts where endemic deaf-mutism is found, possess comparatively good hearing" [158, p. 57]. Kocher also declares that there are deaf-mutes (!) whose hearing is normal [201, p. 597]. In many respects cretenic deaf-mutism would seem to resemble a complication of deaf-mutism and idiocy, which is met with everywhere, and which will be more particularly discussed afterwards. Both are probably an expression of a brain-disease.

The most general classification of deaf-mutism is that which discriminates between the deaf-mutism resulting from *congenital* pathological changes of the organs of hearing, and that resulting from such changes which are *acquired after birth* ; v. TRÖLTSCH sub-divides the latter into earlier and later-acquired deaf-mutism. The former is exhibited in children who have never acquired speech, but who have heard; the latter appears in children after they have learnt to speak [141, p. 618].

It is my intention in the present work to adhere, as far as possible, to the division of deaf-mutism into that caused by congenital deafness and that resulting from acquired deafness. I have endeavoured, so far as I have been able, to show how far these two forms differ from each other in etiology, morbid anatomy, and symptomatology. Although, theoretically, this classification is easily carried out, it is often difficult to distinguish between deaf-mutism resulting from fœtal changes, and that caused by deafness acquired in infancy. In a great number of cases, however, it is easy to determine the origin of deaf-mutism, since numerous investigations, in which the deaf-mutes examined have been divided into these two classes, prove with certainty that each class has its peculiarities, of which a detailed account will be given.

RELATIVE PROPORTION OF CONGENITAL TO ACQUIRED DEAFNESS.—Literature contains numerous statements as to the numerical comparison between deaf-mutes with congenital and those with acquired deafness. E. SCHMALZ collected a number of statistics which had appeared before the publication of his work [70, p. 6], and came to the conclusion that there were about double as many congenital (68 per cent.) as acquired cases (32 per cent.) Hartmann, found, after having examined a number of more recent statistics, that the two groups were almost equal numerically [132, p. 204, tab. 6B]. Hartmann, however, left out of consideration the Irish statistics, which showed, and have since shown, such a remarkably large number of deaf-born as to raise the suspicion that a mistake must have been made in classifying the deaf-mutes according to the origin of their deafness. In the following table the later Irish statistics (1881) are omitted for the same reasons, 3,092 cases of congenital, and only 753 of acquired deaf-mutism, being the numbers found [149, p. 288]. In Table I. I have separated results obtained from census, &c., from those obtained in deaf and dumb institutions, since the information as to the origin of the deafness is arrived at by different methods. This table embraces all those statistics which have appeared since Hartmann's work was published.

TABLE I.—RECENT STATISTICS AS TO THE RELATIVE PROPORTION OF DEAF-MUTES WITH CONGENITAL DEAFNESS TO DEAF-MUTES WITH ACQUIRED DEAFNESS.

COUNTRIES AND PROVINCES:	Congenital.	Acquired.	Uncertain.
Pommerania, 1874-75 [134, p. 197]	592	1,031	—
Erfurt, 1874-75 [*ibid.*]	168	99	—
France, 1876 [123, p. liii.]	16,127	5,268	—
Saxony, 1880 [161, p. 123]	636	649	306
Prussia, 1880 [157, p. 207]	9,468	7,196	11,130
United States, 1880 [180, p. 396]	12,155	10,318	11,405
Scotland, 1881 [156, p. xiv.]	1,078	1,064	—
Mecklenburg-Schwerin, 1885 [210, p. 128]	217	266	33
Norway, 1886 [203, p. 99]	933	885	8
Denmark, 1879-90 [*see* this book, p. 45]	226	208	119
Total	41,600	26,984	—

TABLE I—*continued.*

INSTITUTIONS IN	Congenital.	Acquired.	Uncertain.
Breslau, 1869-79 [125, p. 40]	80	148	42
United States, 1880 [180, p. 298]	1,733	3,088	—
Baden, 1881 [144, p. 117]	181	234	—
Würtemberg, 1881 [*ibid.*]	117	111	—
Austria, 1884 [176, p. 33]	812	480	379
Ludwigslust, 1885 [171, p. 8]	20	37	15
Norway, 1886 [768, p. 73]	132	204	—
Italy, 1887 [176, p. 16]	798	471	376
Total	3,873	4,773	—

The majority of the statistics referred to in Table I., and of other existing statistics as to deaf-mutes, are so full of deficiences, and differ so much from each other, as to necessitate the greatest caution in making comparisons. As the existing statistics concerning deaf-mutes will often be referred to subsequently, I take the opportunity of pointing out these deficiencies and differences before going into the details of the results given in Table I.

Many younger deaf and dumb children are not included in any statistics comprehending the entire population. This is accounted for by the fact that it is often difficult to recognise deaf-mutism in infancy before the child *should* begin to speak, for which reason its deficiency is often not observed until the second year, indeed, not infrequently, later. Besides, it often takes a long time for many parents to give up all hope of their child's learning to speak, and they therefore wait a long time before declaring it to be a deaf-mute. These circumstances explain why there is such a strikingly small number of deaf-mutes in the younger periods of age, especially in the period from 0–5 years of age. For instance, the Irish census of 1880 only gave 35 deaf-mutes belonging to this period of age [149, tab. 107, p. 290], and in the English census of 1881 there were only 498 deaf-mutes under 5 years of age [156, p. 63]. This circumstance is even felt in the period of age from 5–8; this has been plainly proved in Denmark, where, in 1885, the numerical proportions of the periods of age suddenly fell at the age of 8 [Diagram in 200, p. 384], and there is every reason to believe that the number of deaf-mute children not included in the statistics represents at least 10 per cent. of the whole deaf-mute population, and that it may amount to 25 per cent. of the same.

Another fault is that most deaf-mute statistics embracing countries or provinces, reckon the rate of deaf-mutes in relation to the *actual* population of the country. As this consists of the native population minus emigrants and plus immigrants, and as the number of these latter fluctuates greatly in different countries, while the deaf-mute population is more constant, it is evident that statistics, which do not pay sufficient attention to emigration and immigration, must be unreliable as to the proportion of deaf-mutes found.

Further, many statistics give no further information as to the manner in which the material on which they are based has been obtained; indeed some are entirely silent upon this subject. Often there is no information as to how the proportion of deaf-mutes has been arrived at; for instance, if by grouping them according to place of residence, or place of birth. Information is also often wanting whether blind and idiotic deaf-mutes are included or not, as it is often not sufficiently clear whether dumb persons with hearing are included in the results given.

Another error is due to some statistics being compiled by persons especially appointed for that purpose. This plan is doubtless the best guarantee that all deaf-mutes will be included, but that it may have its drawbacks was proved in the Irish census of 1880, when a single enumerator found such an enormous number of deaf-mutes in one district as to arouse suspicion. It was discovered that he had included all children who could not speak [Royal Commission, &c., 149, p. xliv.] In other places the enumeration has been made by the help of schedules, which have been filled in by the deaf-mutes' friends, by the clergy, or by medical men.

Finally, some statistics state what is understood as deaf-mutism, while others do not mention it. This, of course, gives rise to arbitrary decisions.

The only result which can be arrived at with any degree of certainty from Table I. is, that the statement as to the numerical proportion between congenital and acquired deaf-mutism varies greatly in different countries and institutions. Sometimes the two groups are stated to be almost equal, sometimes the one is stated to be larger, and occasionally much larger, than the other. This is doubtless an expression of the great fluctuations to which the comparative proportion of congenital to acquired deaf-mutism is subject. The great difference found in this respect in the returns concerning the whole population of a country (a longer period of time) and those concerning institutions in the same country (a shorter period of time), tends to prove this (America, Norway). It is but reasonable to suppose that there is a connection between the fact stated above and the varying character and intensity with which epidemic diseases—the principal cause of acquired deaf-mutism—appear at different times. The nature of the causes of congenital deaf-mutism is, on the contrary, in all probability more constant. The figures found in the above table can, therefore, lay no claim to absolute validity, for the reasons stated. It is, however, probable that statistics furnished by institutions approach closer to the actual state of things, as, in all probability, greater attention will have been paid to a careful collection of information as to the origin of deaf-mutism in the cases concerned. The French statistics, which contain no rubrics for doubtful cases, are especially suspicious, and it will be observed that by omitting these, as was the case with the Irish, the results yielded by countries and institutions do not differ to so great an extent. When we take into consideration the circumstance that, even in the most carefully drawn up statements from institutions, cases of early acquired deaf-mutism easily creep in amongst the congenital cases, we have reason to surmise that at least half the cases of deaf-mutism in modern times are caused by acquired deafness. Future investigators will perhaps prove that acquired deafness has a still greater preponderance in the causation of deaf-mutism than we are authorised at present in believing.

DISTRIBUTION.—Under this section will be considered the distribution of deaf-mutism in different countries among tribes and creeds, also its unequal distribution in the two sexes.

COUNTRIES.—The distribution of deaf-mutism in different countries was first investigated in the present century by means of statistical enumerations of deaf-mutes. In most countries these enumerations have been conducted at the same time as the ordinary census. We are, however, only in possession of information as to the distribution of deaf-mutism in Europe, the United States of America, and some European colonies. Not even all European countries have undertaken an enumeration of their deaf-mute population—Russia, the largest of them, having, for instance, no deaf-mute statistics. Table II., which includes the most recent enumerations of deaf-mutes, gives their numbers in different countries, also the proportion of males and females.

It will be seen from Table II. that deaf-mutism is very variously distributed in the countries from which we possess statistics concerning later years, the number of deaf-mutes per 100,000 inhabitants varying from 34 (Holland) to 245 (Switzerland). It will also be seen that the frequency of deaf-mutism in Europe is at present, on an average, 79 cases per 100,000 individuals.* The United States have, on the con-

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* Estimating the population of Europe at about 350 millions, and supposing that the average proportion of deaf-mutes found in European countries is common for the whole of Europe, the total number of European deaf-mutes may be supposed to be about 275,000. If we consider the rate given for Europe as common for the whole world, and the population of the world as about 1,600 millions, the result will be that there are altogether above one million deaf-mutes in the world. This is hardly too high a figure, considering that many deaf and dumb children are not included in the statistics [*see* p. 13], and as it is probable that in large countries like China a large proportion of the population live under unfavourable hygienic conditions, there will be a considerable number of deaf-mutes.

TABLE II.—RECENT STATISTICS AS TO THE DISTRIBUTION OF DEAF-MUTES IN VARIOUS COUNTRIES, AND NUMBER OF MALE AND FEMALE DEAF-MUTES IN EACH.

	Aggregate Population.	Number of Deaf-mutes.	Number of Deaf-mutes per 100,000 inhabitants.	Number of Male Deaf-mutes.	Number of Female Deaf-mutes.	Number of Female Deaf-mutes per 100 Males
Switzerland, 1870, [120, p. 344]	2,669,147	6,544	245	—	—	—
Austria, 1880, [150, p. iv.]	22,144,244	28,958	131	15,935	13,023	82
Hungary, 1881, [145, p. 794]	15,642,102	19,874	127	10,589	9,285	88
Baden, 1871, [120, p. 312]	1,461,562	1,784	122	942	842	89
Alsace and Lorraine, 1871, [120, p. 313]	1,549,587	1,724	111	977	747	76
Würtemberg, 1861, [120, p. 312]	1,720,708	1,910	111	1,009	891	87
Sweden, 1880, [164, p. xlv.]	4,565,668	4,834	106	2,681	2,153	80
Prussia, 1880, [157, p. 207]	27,279,111	27,794	102	15,168	12,626	83
Finland, 1880, [167, p. 60]	2,060,782	2,098	102	1,183	915	77
Norway, 1886, [203, p. 97]	1,922,105	1,826	95	1,029	797	77
Bavaria, 1871, [120, p. 312]	4,863,450	4,381	90	2,252	2,129	94
Ireland, 1880, [149, p. 288]	5,174,836	3,993	77	2,163	1,830	87
Portugal, 1878, [142, p. xxvi.]	4,161,980	3,109	75	1,799	1,310	73
Greece, 1879, [176, p. 11]	1,679,551	1,085	65	—	—	—
Denmark, 1890, [218, p. 13]	2,172,380	1,411	65	745	666	89
Saxony, 1880, [161, p. 9]	2,972,805	1,747	59	941	806	86
France, 1876, [123, p. liii.]	36,905,788	21,395	58	11,460	9,935	87
Scotland, 1881, [156, p. xiv.]	3,933,300	2,142	57	1,149	993	86
Italy, 1881, [166, p. 128]	28,461,681	15,300	54	8,707	6,593	76
England-Wales, 1881, [155, p. 63]	25,974,439	13,295	51	7,111	6,184	87
Spain, 1877, [162, p. 732]	16,623,384	7,629	46	4,625	3,004	65
Belgium, 1875, [116, p. 613]	5,336,185	2,280	43	1,208	1,072	89
Holland, 1879, [120, p. 318]	3,575,080	1,199	34	629	570	91
Total . .	222,849,875	176,312	79	92,312	76,371	83
United States, 1880, [1880, p. xii,]	50,155,783	33,878	68	18,567	15,311	82
	273,005,658	210,190	77	110,879	91,682	83

trary, a deaf-mute rate of only 68 per 100,000. It must, however, be remembered that a large proportion of the population of the United States consists of emigrants, and as deaf-mutes do not in all probability emigrate to the same extent as normal individuals, there is reason to suppose that the low deaf-mute rate of the United States can be accounted for principally, or perhaps entirely, on these grounds.

The considerable difference exhibited in the deaf-mute rates of various European countries, naturally gives rise to the question whether this may not be accounted for by the different manner of collecting statistics. There is nothing, so far as those countries are concerned which exhibit low deaf-mute rates, which can authorise a doubt as to the reliability of the statistics in question. Some few of the high rates (Switzerland, Austria, Hungary) may perhaps have been caused by the circumstance that a number of deaf and dumb or dumb cretins, who should be kept quite distinct from deaf-mutes, have been included in the enumeration. This cannot, however, be brought against other statistics exhibiting high deaf-mute rates.

On considering the present geographical distribution of deaf-mutism in Europe the following circumstances are evident. Deaf-mutism appears most frequently in those countries included in a longitudinal belt, which from the extreme north stretches through central Europe to its southern boundary, two minor states, Denmark and Saxony forming the exception. This result would be the same, even if other German states and towns, not mentioned in Table II., were included, since Mayr found the deaf-mute rate of the entire German empire in 1877 to be 97 per 100,000 inhabitants [120, p. 313]. Further, it will be seen that deaf-mutism is comparatively less frequent in the south and west of Europe, the boundaries being pretty distinct. That the difference is considerable is evident, the deaf-mute rate for north and central Europe being 115 per 100,000 inhabitants, while it is only 54 for west and south Europe.

The causes of this remarkably unequal geographical distribution of deaf-mutism are probably numerous and various. To begin with, we are involuntarily struck by the fact, that the countries with large deaf-mute populations are the most mountainous in Europe, which is in complete accordance with the fact that deaf-mutism is more frequent in mountainous than in low-land districts. I shall later on have occasion to point out that this is not, in all probability, the result of great altitudes and peculiar geological formations, but of the unfavourable social and hygienic conditions common to mountainous countries (consanguinity, poverty, unhealthy dwellings, &c.), the importance of which as causes of deaf-mutism will be discussed afterwards. Further, wide-spread and malignant epidemics of cerebro-spinal meningitis, an important cause of deaf-mutism, explain the frequency of this condition in the low-lands of central Europe. We must, also, observe that the countries in the west and south of Europe are the most fertile and productive, while those in the north and centre are less favourably endowed by nature. That this circumstance is a factor in the distribution of deaf-mutism has been proved by investigations made in different districts in Denmark [Mygind, 200, p. 304] and especially in Saxony [H. Schmaltz, 161, p. 81]. Finally, the northern and central countries are on the whole the most thinly populated in Europe, doubtless the result of the barrenness of the soil. The above mentioned investigations in Denmark and Saxony proved that sparseness of population is favourable to the appearance of deaf-mutism, although it might have been supposed that the epidemic diseases, which cause deaf-mutism, would be less easily spread in thinly, than in thickly populated countries, and thus cause a depression in the deaf-mute rate.

A comparison between the present and former deaf-mute rate in Europe and the separate States gives the following result:—E. Schmalz collected the statistics for 1834-40 [70, p. 472] and found in Europe 76·9 deaf-mutes per 100,000 inhabitants. Mayr's survey in 1860-71 gives 78·1 [120, p. 83]. From this it would seem that deaf-mutism is more frequent now than formerly. It must, however, be taken into consideration, that not only is the material, on which the three calculations are based, different, but that the later statistics are in all probability more accurate; therefore, as the difference is slight, there is no reason to suppose that deaf-mutism is more common now than formerly.

By comparing Table II. with those of E. Schmalz and Mayr, it will be seen that the comparative position of the different countries arranged according to their deaf-mute rates, has not undergone any great alteration during the last fifty years. Further, the difference between the rates of the separate countries was not as great about the middle of the century as it is now. There is, furthermore, reason to suppose that there is an increase in the deaf-mute rate in countries with a large deaf-mute population, while there is a decrease in countries with a comparatively small deaf-mute population. These statements are made with reservation on account of the difference which probably exists between earlier and later statistics.

Finally, it must be observed that the deaf-mute rate may vary greatly within the boundaries of each country. For instance the deaf-mute rate varied in Switzerland from 54 (Basel) to 436 (Lucerne) per 100,000 inhabitants, in Alsace-Lorraine from 93 (Lorraine) to 121 (Upper Alsace), in Würtemberg from 63 (Donaukreis) to 158 (Jagstkreis), in Sweden from 88 (Kopparbergs Län) to 167 (Elfsborgs Län), in Prussia from 92 (Hohenzollern) to 182 (East and West Prussia), in Finland from 92 (Uleaborg Län) to 103 (Nylands Län), in Bavaria from 64 (Schwaben) to 141 (Oberfranken), in Ireland from 72 (Leinster) to 90 (Munster), in Denmark from 37 (Maribo) to 109 (Hjörring), in Saxony from 40 (Döbeln-Meissen) to 98 (Olnitz) and in Italy from 43 (Adriatica) to 131 (Alpina).

RACE.—Existing literature throws but little light upon this question; the following is, however, worthy of notice.

Hebrews.—It is a known fact that the Hebrew race produces a larger number of blind and idiotic individuals than the European races among which it lives. It seems, also, at least in many places, to produce a comparatively larger number of deaf-mutes. LIEBREICH [87, p. 54] and KRAMER [HARTMANN, 132,

p. 48] declare that the Hebrew race produces about four times as many deaf-mutes as Catholics and Protestants. These statements are, however, founded on very slight statistical basis. The same may be said of reports from the district of Cologne, Denmark and Mecklenburg-Schwerin [101, p. 11, 200, p. 382 and 210, p. 47], all of which tend to prove a greater frequency of deaf-mutism amongst Hebrews. The Prussian and Bavarian statistics, however, embrace much more important figures. In Prussia there were in 1880, 99 deaf-mutes to every 100,000 Evangelical inhabitants, the corresponding number in the Hebrew population being 144 [GUTTSTADT, 157, p. 208]. The difference was still greater in Bavaria, the rates being 95 and 182 respectively [MAYR, 120, p. 29]. It would seem from the Prussian census of 1880 that the greater frequency of deaf-mutism in the Hebrew population was owing to congenital deafness, there being 34 deaf-born deaf-mutes per 100,000 Evangelical and 65 per 100,000 Hebrew inhabitants. The rates for deaf-mutes with acquired deafness were respectively 28 and 32. On the other hand, it is only fair to state, that while in 1882 the Hebrew population of Hungary was 4·08 per cent. of the whole population, the Hebrew deaf-mutes were only 3·82 of the deaf-mute population [145, p. 796] and that H. SCHMALTZ found that the Hebrew deaf-mutes in Saxony were comparatively few [161, p. 58]; his (H. SCHMALTZ') figures are, however, small, and he adds that the Hebrew population of Saxony fluctuates greatly.

It is, of course, highly improbable that the Jewish faith has anything to do with the frequency of deaf-mutism among its professors. Peculiarities in the race, and social conditions are doubtless the most important factors, the consanguineous marriages so common among Jews, probably playing an important part.

Vandals.—H. SCHMALTZ found that persons of this race furnished a larger contingent to the deaf-mute population of Saxony than those belonging to the Teutonic race [161, p. 59]. LEMCKE, in Mecklenburg-Schwerin, on the other hand, came to the opposite conclusion [210, p. 46].

Roumanians.—According to the Hungarian census of 1882, there was a comparatively larger number of deaf-mutes amongst the Roumanian portion of the population [145, p. 999].

Negroes, *Indians*, *Chinese*, *and Japanese*. — In American statistics these people are included under one heading, "coloured." There were comparatively few deaf-mutes among the coloured population in the United States in 1880, there being 70·2 deaf-mutes per 100,000 "white" inhabitants, and only 48·9 per 100,000 "coloured" inhabitants [180, p. xix.] Former American censuses have given the same result.

CREED.—The frequency of deaf-mutism among professors of the Mosaic religion has been treated of above. So far as other creeds are concerned, statistics from Cologne [101, p. ii.], Ireland [149, p. 41], and Prussia [157, p. 208], have proved a greater frequency of deaf-mutism among catholics, while those from Bavaria [120, p. 29], Saxony [161, p. 58], and Hungary [145, p. 796], have shown a comparatively greater frequency amongst Protestants, or other non-catholic Christians (Saxony, *loc. cit.*) Again, other statistics show no difference in the frequency of deaf-mutism among professors of various faiths, for instance, those of Mecklenburgh-Schwerin, 1874-75 [210, p. 48]. It is, therefore, probable that different creeds, *per se*, play no part in the distribution of deaf-mutism.

SEX.—Table II. shows a greater frequency of deaf-mutism among males than females, the difference in several countries being considerable. The number of female deaf-mutes per 100 male deaf-mutes varies, according to the table, from 94 in Norway to 65 in Spain, the average rate for Europe and the United States of America being 83 females per 100 males. The numerical superiority of male deaf-mutes is the more remarkable since females are more numerous than males in nearly all European countries, Italy being the only state of those mentioned in Table II. which exhibits a slight inferiority as regards the female population, the United States having also a larger male population. Male deaf-mutes are, however, in all European countries absolutely more numerous than female deaf-mutes, and comparatively, this numerical superiority is still more marked, the difference in many places being very considerable. In Spain in 1877, there were, for instance, 34 female deaf-mutes to every 100,000 female inhabitants, and 57 male deaf-mutes to the same number of males; in Denmark, in 1885, the figures were respectively

60·9 and 66·6, these two countries representing the two extremes.

A comparison between Table II. and SCHMALZ' survey [70, p. 69a] proves that the numerical superiority of male deaf-mutes was greater formerly than at present, SCHMALZ having found 74 female deaf-mutes to every 100 males, more recent calculations giving 83 females per 100 males. This seems to point to a lesser frequency of deaf-mutism among males at present, or to a greater frequency among females—perhaps to both. In Denmark, the male deaf-mute rate has remained almost stationary from 1855–1885, while the female deaf-mute rate has increased steadily and considerably [MYGIND, 200, p. 380].

There is a circumstance which must be taken into consideration before any other when seeking for the cause of this numerical superiority among male deaf-mutes. I mean the well-known fact that a greater number of males are born than females, and that this numerical superiority holds good for a considerable time, often into the second decade of life. It is, therefore, natural that there should be a greater number of male children born deaf than female, also that a greater number of boys than girls become deaf and dumb through acquired deafness. On the other hand, we can but suppose that the greater mortality to which male individuals are exposed would also influence the deaf-mute population. It is, however, possible that such is not the case; it has at least been proved in Norway [UCHERMANN, 203, p. 98], and in Denmark [MYGIND, 200, p. 391], that the mortality among adult female deaf-mutes in the younger periods of age is, as compared with that of the general population, very considerable. We have no information as to childhood. All statistics which treat of this subject prove that the younger the deaf-mutes are, the greater is the numerical superiority of the males, and *vice versa*, until at last, during the later decades of life, female deaf-mutes become more numerous than males.

The circumstance that ear-diseases are more common among males than females, is, perhaps, another explanation of the greater frequency of deaf-mutism among males, it being a well-known fact that deaf-mutism is nearly always caused by ear-disease. This possibility has been pointed out by Carus in his *System der Physiologie* (vol. ii., p. 235), who mentions the greater development of the male organs of hearing, and the consequent predisposition to pathological changes. To this the objection may be raised that it is but evading the question, and further, that it is difficult to prove or disprove the greater predisposition of males to ear-disease by statistics as to the frequency with which males *come under treatment* for ear-troubles. This hypothesis is, therefore, contestable.

There is also a possibility that the greater frequency of deaf-mutism among males may have some connection with the circumstance that acquired deafness is often the result of brain-disease, more especially cerebro-spinal meningitis, which attacks boys much more frequently than girls, just as other brain-diseases are more common among males than females, which has been clearly proved, for instance, with respect to idiocy.

Mayr believes that the greater predisposition of the male sex to deaf-mutism is a consequence of the dependence of this condition upon an increased infant mortality [120, p. 28]. According to E. Schmalz [70, p. 70a], Mathias supposes the frequency of deaf-mutism among illegitimate children (among whom there is a great preponderance of males) to be a cause of the larger number of male deaf-mutes. I shall, further on, have occasion to prove how far Mathias' supposition is correct.

Congenital and Acquired Deafness in the Two Sexes. An investigation as to how far the numerical relations between male and female deaf-mutes are the same for deaf-born deaf-mutes and those with acquired deafness, may be of interest, and also serve to throw some light upon the circumstances mentioned above. I have collected the existing statistics in the following survey, in which the number of female deaf-mutes per 100 males is given for each place.

	Congenital.	Acquired.
Belgium, 1835 [Sauveur, 64, p. 15] . . .	82	80
Cologne, 1870 [Lent, 101, p. 7]	89	74
Magdeburg, 1871 [Wilhelmi, 108, p. 65] .	84	90
Pommerania-Erfurt, 1874–75 [Wilhemi-Hartmann, 134, p. 199]	89	83
Prussia, 1880 [Guttstadt, 157, p. 210] . .	83	81
Saxony, 1880 [H. Schmaltz, 161, p. 62] .	94	83
Ireland, 1881 [Census, 149, p. 290] . . .	84	89
Norway, 1885 [Uchermann, 203, p. 99] .	89	66
Mecklenburg, 1885 [Lemcke, 210, p. 49] .	104	94
Denmark, 1879–90 [this book, p. 45] . .	87	64

According to the above the numerical superiority of male deaf-mutes is greater among those with acquired deaf-mutism than among congenital deaf-mutes in all places where the matter has been investigated. In Norway, where Uchermann has submitted the subject to more minute investigation, it has been proved that the numerical superiority of male deaf-mutes in the period of age 0–20 is entirely owing to acquired deafness [203, p. 99]. The circumstance that a wide-spread epidemic of cerebro-spinal meningitis visited Norway about fifteen years prior to the drawing up of Uchermann's statistics throws some light on the above, and speaks greatly in favour of the supposition laid down, (p. 27,) as to the influence which brain-diseases exercise over the frequency of deaf-mutism among males.

CHAPTER I.

ETIOLOGY AND PATHOGENESIS.

THIS chapter will be devoted to the remote and immediate causes of deaf-mutism. Under the immediate causes will also be given an account of the manner in which these affect the organs of hearing, and thus produce the pathological changes which lead to deaf-mutism.

NATURAL CONDITIONS.—On considering the unequal distribution of deaf-mutism in Europe (p. 18), we are involuntarily led to the supposition that this phenomenon may be caused by varying natural conditions, among which soil and elevation seem to play an important part, since deaf-mutism is particularly frequent in the mountainous parts of Switzerland and of the neighbouring countries.

GEOLOGICAL CONDITIONS AND ELEVATION.—The dependence of deaf-mutism upon geological conditions was first brought forward by ESCHERICH [75, p. 145]. This author believed that deaf-mutism—like endemic cretinism and struma—is more frequent in old formations than in new, the boundary between the two being the Jurassic formation. Escherich proved his hypothesis by the distribution of deaf-mutism in Europe, according to then-existing statistics (1854), and by the conditions in Bavaria, where Swabia, with its comparatively more recent geological strata, exhibited the lowest deaf-mute rate, while Unterfranken, which consists entirely of older geological formations, showed the highest. Belgium and Würtemberg yielded, according to Escherich, similar data in favour of this theory.

Georg Mayr found that his map of the distribution of deaf-mutism in South Germany supported Escherich's hypothesis, the triassic areas of geological formation showing a comparatively large number of deaf-mutes [120, p. 40]. Mayr, however, considered that there were facts which could be brought against such a supposition, since the same formation may exhibit a high deaf-mute rate in the one part and a low one in another; he was, therefore, of opinion that the nature of the soil is not the sole cause, but that other conditions play an important part. Mayr comes, however, to the final conclusion that "territorial" conditions are the most important causes of the unequal distribution of deaf-mutism, and ends by saying "Mountains will, as a rule, have a high deaf-mute rate, but this is not a necessary consequence; valleys and lowlands will, as a rule, enjoy a relative immunity."

Bircher is also in favour of the above-mentioned theory of Escherich, and points out that investigations in Switzerland, where deaf-mutism and cretinism appear endemically in the same parts of the country, have proved that deaf-mutism is particularly common where the soil consists of the older formations, and especially of those which belong to the Triassic strata, and is less frequent in the more recent geological formations [158, p. 79, and following].

The principal objection to be raised against the above-mentioned opinions as to the importance of geological conditions in the causation of deaf-mutism, is that the investigations upon which these views are based have not also been directed towards the discovery of other possible conditions connected with the geological formations, which might account for the existing high deaf-mute rate. MAYR has, it is true, called attention to two circumstances which may be of some importance in South Germany, namely, the high infant mortality which actually exists in these parts (see below), and the variety of races of which the population is composed. He does not, however, go fully into the subject.

To H. SCHMALTZ is due the honour of having investigated the question of the importance of geological conditions and elevation in Saxony so thoroughly that his results are entirely to be relied upon. In these investigations, which have embraced the minutest details which could possibly be of importance concerning the appearance of deaf-mutism, the author has weighed each separate point carefully. His conclusions are as follows [161, p. 178, and following]: There is nothing to be said in favour of the hypothesis that soil, climate, or other territorial conditions, influence the deaf-mute rate, neither can the composition of the water be proved to affect it in any way, but it is the social and hygienic conditions which are decisive. LEMCKE, in Mecklenburg-Schwerin, was also unable to prove that geological conditions are a cause of deaf-mutism [210, p. 30].

We cannot, therefore, draw any certain conclusions from existing information as to the dependence of deaf-mutism upon natural conditions. It must, however, be admitted that it is extremely difficult to produce positive proofs in support of the supposition that natural conditions influence the deaf-mute rate, neither can the fact be denied that mountainous districts exhibit a high deaf-mute rate, even if they belong to countries with a comparatively small deaf-mute population; for instance, Saxony [161, p. 45], France [120, p. 84], Ireland [72, p. 462], and England [155, p. 64]. The Swiss Alps and their spurs in the neighbouring countries exhibit an especially high deaf-mute rate, the census in the Canton of Wallis in 1870 showing 492 deaf-mutes per 100,000 inhabitants. As far as the Swiss Alps are concerned, there can be no doubt that it is cretinic deaf-mutism which makes the rate so high, and, as pointed out on page 10, this abnormality must be distinctly separated from the form of deaf-mutism treated of in this book. It is impossible at present to discover whether it is not this form of deaf-mutism which influences the deaf-mute rates of other mountainous districts, but it would not seem to be improbable. In low-lying districts in Europe the deaf-mute rate is generally low, even when these districts are situated in countries with large deaf-mute populations; for instance, certain low-lying districts in Hungary [120, p. 88]. Some of the Dutch provinces on the North Sea and Zuyder Zee exhibit the lowest deaf-mute rate, and in one place, Oberijsel, it sinks to 8·5 per 100,000 inhabitants [120, p. 344].

There are, however, several exceptions to these rules. Thus, some of the Swiss Alps, especially those in the Cantons of Appenzell, St. Gallen, Glarus, Schwyz, and Unterwalden, exhibit a comparatively low deaf-mute rate, and East Prussia, West Prussia, Posen, and Pommerania, are examples of low-lying countries with high deaf-mute rates. So far as the latter are concerned it is reasonable to suppose that this is owing to a severe epidemic of cerebro-spinal meningitis, a circumstance which has been pointed out by HARTMANN [134, p. 322]. It is, however, a remarkable fact that the census of 1880 did not show a much greater number of deaf-mutes with acquired than with congenital deaf-mutism in these parts of Prussia [GUTTSTADT, 157, p. 210].

CLIMATE.—It has already been stated that H. SCHMALTZ did not consider climate to have any influence upon deaf-mutism as far as Saxony was concerned. It is also worthy of mention that the northern regions of Norway, Sweden, and Finland, which lie about the 70th degree of latitude, do not exhibit a remarkably high or low deaf-mute rate.

WATER.—BIRCHER considers the composition of the drinking-water as being of the utmost importance as a cause of the endemics of cretinic degeneration in Switzerland, among which he includes endemic deaf-mutism. Bircher considers cretinic degeneration as a chronic infectious disease, the miasma of which is connected with certain marine deposits in the soil, and which are introduced into the human body through the drinking-water [158, p. 152]. Cretinic deaf-mutism seems, however, as previously stated, to be distinct from ordinary deaf-mutism. H. Schmaltz, on the other hand, found no connection between drinking-water and deaf-mutism in Saxony [161, p. 39], which was also the case with Lemcke's investigations in Mecklenburg-Schwerin [210, p. 34]. It is, however, worthy of mention that H. Schmaltz found a remarkably large number of deaf-mutes in Saxony in parts where the rivers and water-courses were polluted [161, p. 41]. Schmaltz seeks an explanation in the circumstance that polluted rivers and water-courses produce unfavourable hygienic conditions; he also points out that such pollutions are often caused by factories, &c., and it is a fact that the deaf-mute rate is perceptibly increased in the neighbourhood of large industrial establishments, &c. (*see* below).

UNFAVOURABLE SOCIAL AND HYGIENIC CONDITIONS.—Almost all authors, who have considered the question of the connection between deaf-mutism and unfavourable social and hygienic conditions, agree in ascribing to them great importance as causes of deaf-mutism. The statistical proofs in support of this hypothesis are not, however, on the whole, very satisfactory. The principal reason is probably that, as a rule, there is no material from which to draw a comparison as to the deaf-mute rate of the favourably and unfavourably situated classes of society. To this is added the difficulty of deciding in individual cases in how far a deaf-mute must be considered as belonging by birth to the favourably or unfavourably situated classes of society [*see also* HARTMANN, 132, p. 69]. In the following pages a number of facts will be brought forward which support the supposition of a connection between deaf-mutism and unfavourable social and hygienic conditions.

It must first be observed that it is to H. SCHMALTZ's investigations in Saxony that we owe a series of facts which throw a light upon the remote causes of deaf-mutism. These facts are principally as follows [161, p. 78, and following]: The agricultural districts in Saxony produce a comparatively small number of deaf-mutes, while the industrial districts show a high deaf-mute rate. Those parts of the country in which there are a number of small industries, and where valuation yields a comparatively small return, exhibit, as a rule, a higher deaf-mute rate than those parts where there are large landed estates which pay high taxes. In several districts where unfavourable conditions have forced the inhabitants to make extensive use of cows as draught animals, the deaf-mute rate is high, which is also the case in districts where there are large numbers of pigs, owing to the inhabitants not being able to afford to keep other animals, pork being, therefore, the principal meat eaten. SCHMALTZ found also that in districts where the potato was principally grown, and consequently formed the staple article of food, the deaf-mute rate was high, and this was also the case in districts where the consumption of meat was small. Further, the deaf-mute rate was higher among factory hands than among artisans, and also higher among the untaxed population than among those who paid taxes. There were also a greater number of deaf-mutes among the working classes (factory hands, miners, artisans,* &c.), than among the professional and business classes (lawyers, medical men, officials, &c.) Finally, there was a greater number of deaf-mutes in those districts where it could be statistically proved that certificates of death were comparatively seldom written by medical men, owing to the great distances at which the latter were situated.

Investigations made in Denmark tend in the same direction, but are not based on such detailed and thorough researches as those of SCHMALTZ [MYGIND 200]. We may merely mention that the deaf-mute rate in Denmark was found to be in proportion to the fertility of the soil and the density of population, fertile and thickly-populated districts exhibiting a low deaf-mute rate, whilst unfertile and sparsely-populated districts exhibited a high rate—circumstances which have already been noticed (p. 21).

In Mecklenburg-Schwerin LEMCKE found that the majority of the parents of the deaf-mutes in that Duchy lived under unfavourable economical and hygienic conditions [210, p. 75].

The remarkable conformity between the deaf-mute rate and infant mortality in South Germany, as pointed out by Mayr [120, p. 40], is another argument in favour of the influence of unfavourable hygienic and social conditions upon deaf-mutism, as it is well known that a high infant mortality is closely related to such conditions. It is also very probable that the high deaf-mute rate exhibited by mountainous countries points in the same direction.

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* Millers' children seem to be particularly exposed to deaf-mutism [HARTMANN, 132, p. 70; H. SCHMALTZ, 161, p. 91; LEMCKE, 171, p. 14; MYGIND, 200, p. 398]. There is, up to the present time, no satisfactory explanation of this phenomenon.

All the above-mentioned circumstances point more or less emphatically towards the considerable influence which unfavourable social conditions exercise as remote causes of deaf-mutism. It can hardly be supposed that they are in themselves of decisive importance; it is much more probable that the unhealthy conditions to which the less favourably situated classes are exposed play the most important rôle. H. Schmaltz lays great stress upon this in his valuable work on deaf-mutism in Saxony, ending his book with the following remarks: "The industrial population, and especially that part of it which is worst off from a pecuniary point of view—in fact, all who are in danger of degenerating both morally and physically on account of insufficient means, or poverty, and who consequently are unable or unwilling to take the necessary care of their children—all such persons exhibit the highest percentage of deaf-mutes among their descendants. Finally, we found that when, in addition to all these unfavourable conditions under which children are born, they are brought up by a family which from various reasons is perhaps already more or less degenerated, and have to undergo all sorts of diseases in infancy without having sufficient power of resistance, then deaf-mutism is an only too common result."

These remarks plainly express the author's opinion that unfavourable social and hygienic conditions are of importance as remote causes of both congenital and acquired deafness which leads to deaf-mutism. We cannot at present decide which of the two forms is most affected by these causes, as none of the investigations which treat of the subject distinguish between acquired and congenital deafness.

It may be mentioned in connection with the above, that WILDE found deaf-mutism to be more common in Ireland among the rural than among the urban population [72, p. 474]. Later authors have come to the same conclusion, but a satisfactory explanation has not been discovered.*

There is, however, reason to doubt the correctness of this apparently well-founded supposition. All the statistics which serve as a basis for this hypothesis have calculated the relation of the deaf-mute population to the population *living* in the towns and rural districts. It is, however, an accepted fact that in most countries there is a strong tendency in the population to emigrate from the rural districts to the towns, and especially to the large towns. The consequence is that the deaf-mute rate is put at too high a figure when the deaf-mutes *born* in the rural districts are calculated in relation to the *existing* population, viz., the population remaining in the rural districts. On the other hand, the urban deaf-mute rate will be too low if it is calculated according to the number of deaf-mutes born in a town in relation to the number of inhabitants born in it plus immigrants. Neither can a calculation of the numerical relation between the deaf-mutes living in a place and the resident population give satisfactory results, until we have some knowledge of deaf-mute emigration from the rural districts to the towns in proportion to the emigration of the rest of the population.

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* SCHMALTZ endeavours to explain the circumstance by the greater ease with which medical aid is obtained in towns than in rural districts, the consequence being that ear-disease and epidemic disease do not injure the organs of town children as much as those of country children [161, p. 71].

Up to the present, Denmark is the only place where a calculation of the deaf-mute rate has been made, by comparing the number of deaf-mutes *born* in the towns and rural districts to the population *born* respectively in the towns and rural districts. The results show that, while the deaf-mute rate was lowest in the capital, somewhat higher in the other towns, and highest in the rural districts, when a comparison was made between the deaf-mutes *born* in the respective places and the *actual* population, it was about the same in the three parts of the country when calculated in proportion to the population *born* there. Future investigations in other countries will perhaps prove that the high deaf-mute rate of rural districts is only apparent, and also that the low rate in the towns, and especially the large towns, is owing to the attraction which they have for the rural population.

On the other hand, there can be no doubt that deaf-mutism caused by acquired deafness is comparatively more common in towns than in the rural districts (compared with that caused by congenital deafness [H. SCHMALTZ, 161, p. 71, UCHERMANN, 203, p. 100, and LEMCKE, 210, p. 43]). This is, doubtless, explained by the circumstance that epidemic diseases, which are of so much importance as causes of deaf-mutism, spread more rapidly, and are more severe in towns than in the rural districts. H. Schmaltz found acquired deafness to be the principal cause of deaf-mutism in towns, and that congenital deafness was the principal cause in the rural districts, and in Norway, Uchermann came to the same result.

HEREDITY.—This interesting, but somewhat involved, question, has been the subject of much discussion. The solutions have been various, authors having entertained the most opposite opinions. The literature of the early part of the present century scarcely touches upon the subject; the general opinion seems, however, to have been that deaf-mutism was hereditary. According to Mansfeld [39, p. 577], deaf-mutes in Prussia were even forbidden by law to intermarry; this is, however, denied by Lent [101, p. 23], but an official report is extant, according to which the Over-consistory of Darmstadt, as late as 1871, sought a declaration as to the lawfulness of marriage between two deaf-mutes [104, p. 161]. In 1836, Kramer was of opinion that heredity could not actually be considered to be a cause of deaf-mutism, as there was no case on record of deaf and dumb parents having borne deaf-mute children, and he supported Mansfeld's opinion, expressed some years previously, that heredity only makes itself felt in some few cases [39, p. 577]. Puybonnieux [64, p. 25], E. Schmalz [70, p. 13], and Meissner [76, p. 92], were of the same opinion, whilst Menière [63, p. 223] and Landes [78, p. 34], though both with a certain reservation, considered deaf-mutism to be hereditary. Hudson [61, *see* 70, p. 515] and Sauveur [67, p. 27] declared themselves more decidedly in favour of the theory of the heredity of deaf-mutism. The latter author considered that, although deaf-mutism is not directly hereditary, it often appears in collateral branches, or after the lapse of one generation or more, this opinion being based on the results of the Belgian statistics of 1835. Wilde is the author who lays the greatest stress upon the hereditability of deaf-mutism, declaring that hereditary taint and family peculiarity are of great importance in deaf-mutism [72, p. 472].

Among later authors, Lent is of opinion that deaf-mutism cannot be considered to be hereditary, but that family peculiarity may make itself felt [101, p. 21]. The author, who has gone most minutely into the question, is Mygge, and he comes to results which are more in favour of the hereditary character of deaf-mutism than against it [122]. Hartmann seems to be of the same opinion [132, p. 54], and Mygind considers hereditary influences to be of great importance in deaf-mutism caused by congenital deafness, although congenital deafness is seldom transmitted directly [189, p. 27].

Opinions have thus differed greatly during the present century, and even now there is no agreement upon the subject. The reason is not only that the laws which govern the hereditability of pathological changes and disease are difficult of interpretation, but that the term heredity is differently employed. The material which forms the basis of the various investigations has, too, been very different. In the following pages it will be seen that individual authors have collected statistics in proof of their opinions in a different manner, and while some have considered heredity as only expressing the appearance of a pathological condition in two consecutive generations, others have used the term as expressing the same also when it appears in the collateral branches of a family, while others have considered the appearance also of kindred pathological conditions in the same family as proofs of heredity.

The existing facts, with the addition of some new ones, will be collected in the following pages (without reference to any particular theory) in so far as they throw any light upon the frequency with which deaf-mutism appears in the deaf-mute's family, and in a particular branch of the family tree. The appearance of various other kindred pathological conditions in the deaf-mute's family will also receive special attention. An endeavour will then be made to arrange the results thus obtained under a general theory as to the heredity of deaf-mutism.

Some statistics collected in Denmark, and not yet published, are especially worthy of notice among more recent contributions to the elucidation of our knowledge of the heredity of deaf-mutism. As these statistics will be often referred to in other sections of this work, it may not be out of place to give some account of them here. As explained elsewhere [200, p. 374], all deaf-mutes in Denmark are annually reported to the Minister of Ecclesiastical and Educational Matters, on forms especially printed for that purpose; of these there are two kinds, those for the first reports, and those for the subsequent history. The first form contains a number of questions referring to the causes of deaf-mutism. Thus, important information has been obtained since 1879 (when these forms were first used in their present shape), which serves to elucidate numerous questions which will be noticed afterwards. This information is of the greater importance since the greater number of questions contained in the forms are answered by medical men who, in many cases, have had personal acquaintance with the deaf-mute in question. From 1879–90 553 deaf-mutes have been reported in Denmark for the first time. Of these 553, who were born from 514 unions, (several having the same parents,) 226 were undoubtedly born deaf, and these were the fruit of 197 unions. 208 of the 553 deaf-mutes were undoubtedly suffering from acquired deafness; these were the fruit of 205 unions. Nothing could be positively affirmed as to the origin of deafness in the remaining 119, who were the fruit of 116 unions. Detailed information as to these deaf-mutes will appear in the following.

DEAF-MUTISM IN THE FAMILY OF THE DEAF-MUTE.—Particular attention will be paid to the frequency of deaf-mutism in the different generations of the deaf-mute's family in order to facilitate the consideration of this question. It is, however, often difficult, sometimes even impossible, to produce such conformity between the different statistical reports as to make them suitable as a basis for collective statistics. The reason is that the information published is often very brief and slight, and is also often very deficient in other respects.

Deaf-mutism among the Children of Deaf-mutes.—There are two ways of stating the frequency with which deaf-mutism appears in two consecutive generations. The one is to discover how often deaf and dumb children are born in marriages contracted by deaf-mutes, the other is to find out how frequently deaf and dumb individuals belonging to larger groups of deaf-mutes can trace their descent from such marriages. The first is undoubtedly the most reliable. It is impossible to make use of the numerous reports of single cases in which deaf and dumb children have been born in marriages contracted by deaf-mutes, to prove the frequency with which such marriages produce deaf-mute offspring. It is only by collecting all the marriages contracted by deaf-mutes in a certain country or province into a group, and, by investigating the number of these marriages which have produced deaf-mute children, and the number of the latter, that it is possible to arrive at reliable conclusions. This method was adopted by MYGGE, who revised reports from Ireland, Belgium, Hesse, Berlin, Warsaw, Leipsic, Groeningen, Hartford, and New York, and came to the following conclusions. In 367 marriages in which either husband or wife was deaf and dumb, there were born, altogether, 22 deaf and dumb children [122, p. 10], *i.e.*, one deaf-mute child in every 16th or 17th marriage. There was, however, only one deaf-mute child born in every 30th or 31st marriage where only the one parent was deaf and dumb, while this was the case in every 6th or 7th marriage where both husband and wife were deaf-mutes.

HARTMANN made a statistical revision of the reports from Ireland, Nassau, Magdeburg, and Cologne [132, p. 55], and found that no deaf children were born in the nine marriages in which both husband and wife were deaf and dumb, while six deaf-mute children were born in the 206 marriages where either husband or wife was deaf and dumb, *i.e.*, one deaf-mute child to every 34th or 35th marriage, which latter result is very similar to Mygge's.

A revision of the statistics which have appeared since Hartmann's work was published gives the results comprised in Table III. According to Table III., one deaf-mute child was born in every 13th or 14th marriage where both husband and wife were deaf and dumb. These figures differ considerably from

Table III.—Number of Deaf and Dumb Children born in Marriages contracted by Deaf-mutes.

The Figures in parentheses refer to Illegitimate Unions.

	Both Parents Deaf and Dumb.				One Parent only Deaf and Dumb.			
	No. of Marriages.	No. of Marriages with Deaf and Dumb Children.	No. of Children.	No. of Deaf and Dumb Children.	No. of Marriages.	No. of Marriages with Deaf and Dumb Children.	No. of Children.	No. of Deaf and Dumb Children.
Pommerania Erfurt, 1874 [134, p. 316]	8	0	14	0	39 (+ 31)	3 (+1)	71 (+ 44)	4 (+1)
Saxony, 1880, [161, p. 139]	41	2	79	5	91 (+ 34)	0 (+2)	288 (+ 39)	0 (+3)
Denmark, 1885, [200, p. 418]	35	2	40	2*	65 (+ 9)	0 (+0)	145 (+ 14)	0 (+0)
Mecklenburg, 1885, [210, p. 102]	9	0	2	0	19 (+ 28)	0 (+1)	54 (+ 48)	1 (+1)
Total . .	93	4	135	7	214 (+102)	3 (+4)	560 (+145)	5 (+5)

* Not reported until the author had finished his investigations.

Mygge's, but accidental circumstances must be taken into consideration when the figures are as small as in the present case. The table shows further that one deaf-mute child was born in every 42nd or 43rd marriage where the one parent only was deaf and dumb; but if illegitimate unions are included—as in Hartmann's statistics—it will be found that one deaf-mute child was born in every 31st or 32nd union where only the one parent was deaf-mute. There is thus but a slight difference between these results and those arrived at by Mygge and Hartmann, and as the figures on which the calculation is based are not so very small, one may consider them as being of some absolute value. Neither do the figures for all marriages (including both those where the one parent and those where both parents were deaf-mutes), viz., one deaf-mute child to every 24th or 25th marriage, differ greatly from Mygge's. Table III. shows also that double as many deaf-mute children are born in illegitimate unions where the one parent or both were deaf-mute, as in marriages of like nature—a circumstance which can scarcely be accidental.

The following circumstances must be taken into consideration in judging of the frequency with which deaf-mute children are born of deaf and dumb parents. To begin with, there is reason to suppose that the number of deaf-mute children stated as being born in marriages where the one parent, or both, were deaf-mute, is too low, as there is a possibility of children having been born in these marriages after the respective investigations were concluded. This circumstance is the more worthy of attention, as it has been proved in Denmark and elsewhere that deaf-mutes exhibit a constantly increasing tendency to marry. Consequently statistical investigations, especially the more recent, will show a comparatively considerable number of deaf-mutes who have been only married for a short time. This has also been proved to be the reason why so few children are born in marriages contracted by deaf-mutes [200, p. 416 and following]. Table III. shows that the average number of children to each marriage was 2·3. We can, doubtless, arrive at a more accurate idea of the degree in which the children of deaf-mutes are exposed to deaf-mutism, by finding out how many deaf-mutes there are among all the children born in marriages contracted by deaf-mutes. According to Table III., 0·9 of the children born in marriages where the one parent was a deaf-mute were deaf and dumb, while this was the case with not less than 5·0 per cent. in marriages where both parents were deaf and dumb. If the two groups are considered together, we find that every 57th or 58th child born in marriages contracted by deaf-mutes is deaf and dumb; this figure is very near to that found by Mygge (every 62nd) from quite different statistical material, and may, therefore, be considered as a pretty reliable expression of the frequency with which deaf-mutes have deaf and dumb children. There is no doubt that this frequency is very considerable, although there are no statistics as to the frequency with which deaf-mutes are born in marriages contracted by non-deaf-mutes; still we can be sure that every 57th or 58th child born is not a deaf-mute. It must also be remembered, in considering the frequency with which deaf-mute children are born of deaf and dumb parents, that according to Table III. marriages between two deaf-mutes more often produce deaf and dumb children than marriages where only one parent is deaf-mute. This tends to prove that deaf-mutism in the children of deaf-mutes is not accidental, but the result of hereditary influences which are intensified when coming from both parents at once. Finally, it must be observed that most statistics make no distinction between marriages contracted between congenital deaf-mutes and those with acquired deafness. There is no doubt that if the latter group could be separated from the former, we should find a larger percentage of deaf and dumb children born in these marriages. LEMCKE [210, p. 102] and H. SCHMALTZ [161, p. 139] have made this distinction without arriving at any decided difference, which could hardly be expected since the figures in question are so small.

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Deaf-mutism among the Parents of Deaf-mutes.—The other mode mentioned (p. 46) of estimating the frequency with which deaf-mutism appears in two generations, consists in discovering how often deaf and dumb individuals belonging to larger groups of deaf-mutes are descended from deaf and dumb parents. This method is often employed, but does not, as a rule, prove reliable, because the necessary standard is wanting by which to judge of the results obtained, namely, a knowledge of the frequency with which deaf-mutes marry. This varies greatly in different places [200, p. 407], and explains the varying frequency with which deaf-mute parents are proved to have deaf and dumb children. From statistics from various deaf and dumb institutions, MYGGE found that every 116th or 117th pupil was born of deaf-mute parents [122, p. 20], while in the Royal Deaf and Dumb Institution in Copenhagen, he only found two children with deaf and dumb parents among 514 pupils. Of 415 deaf and dumb children, HEDINGER only found one with deaf-mute parents [144, p. 114]. Among the 553 deaf-mutes in Denmark, mentioned on p. 45, only two individuals, both with congenital deafness, were found to have had deaf-mute parents (both parents). MYGGE found, as did ESCHCKE [25, p. 186], that deaf-mutism is more frequently transmitted through the male than through the female line. This was not the case with the 553 deaf-mutes in Denmark, in which group were found 14 deaf-mute relatives on the father's side and 14 on the mother's, nothing being known as to four relatives. WILDE says: "This does not hold good in Ireland, so far, at least, as congenital mutism is concerned" [72, p. 474], and LENT's results tend in an opposite direction [101, p. 31]. Should it be proved that deaf-mutism is more frequently transmitted through the male line than the female, an explanation might perhaps be sought in the circumstance that male deaf-mutes marry more frequently than female.

Deaf-mutism among the Brothers and Sisters of Deaf-mutes.—It is a well-known fact that deaf-mutes often have deaf and dumb brothers or sisters, even if there is no other case in the family. Most authors who have searched for the frequency of deaf-mutism in the various branches of the deaf-mute's family, have found that it appears more frequently in the relationship mentioned than any other. This will be easily seen on comparing the figures which follow with those on p. 47 and following. The deaf-mutes in Denmark, mentioned on p. 45, are quoted here as an example. Of these, 110, viz., about one-fifth, had one or more deaf and dumb brothers or sisters, but only 37, viz., about one-fifteenth, had one or more deaf and dumb relations in more remote degrees. It is doubtless still more frequent for congenital deaf-mutes to have deaf and dumb brothers or sisters, which supposition has been supported by the statistics mentioned above, as not less than 90 of the 226 congenital deaf-mutes, *i.e.*, about 40 per cent., had deaf and dumb brothers or sisters.

This method of calculation has, however, one fault, viz., that the above-mentioned group of deaf-mutes, as well as all larger groups, includes a number of individuals who are born of the same parents. For this reason I have not given any analysis of the various reports from different places, these reports differing also so much from each other as to make them unsuitable as material upon which to base comprehensive statistics. A reliable result can only be arrived at by arranging the deaf-mute children, not according to their own number but according to the number of marriages (or illegitimate unions) they represent, and by then arranging the latter according to the number of deaf-mute children produced in each. It is thus easy to see the frequency with which such marriages produce one, two, three, or more deaf-mute children.

According to Table IV., about 15 per cent. of the marriages which result in deaf-mute offspring produce

TABLE IV.—FREQUENCY WITH WHICH ONE OR MORE DEAF-MUTE CHILD IS BORN IN MARRIAGES PRODUCING DEAF-MUTE OFFSPRING.

	Number of Marriages with									
	1 Deaf-mute Child.	2 Deaf-mute Children.	3 Deaf-mute Children.	4 Deaf-mute Children.	5 Deaf-mute Children.	6 Deaf-mute Children.	7 Deaf-mute Children.	8 Deaf-mute Children.	9 Deaf-mute Children.	10 Deaf-mute Children.
Nassau, 1864 [93, p. 12] . . .	272	31	7	4	0	0	0	0	0	0
Cologne, 1870 [101, p. 27] . .	305	25	4	4	0	0	0	0	0	0
Magdeburg, 1871 [108, p. 76] .	459	34	13	7	0	1	0	0	0	0
Denmark, 1868–77 [122, p. 40]	390	38	13	1	1	0	0	0	0	0
Saxony, 1881 [161, p. 138] . .	1,329	87	24	3	0	1	0	0	0	0
Ireland, 1881 [149, p. 42]* . .	2,506	324	149	38	22	5	0	0	0	1
Mecklenburg, 1885 [210, p. 112]	385	36	22	7	1	0	0	0	0	0
Denmark, 1879–90 (*see* p. 45) .	441	43	20	7	3	0	0	0	0	0
Total . .	6,087	618	252	71	27	7	0	0	0	1
Per cent. .	86·2	8·7	3·6	1·0	0·4	0·1				

two or more deaf-mute children.† This corresponds pretty closely with the figures found by HARTMANN [132, p. 59], neither does it differ much from results arrived at in Saxony [161, p. 138]. H. SCHMALTZ draws attention to the circumstance of "*die enorme Überwiegen der vereinzelten Fälle*" as being a poor proof of the heredity of deaf-mutism; against this it can be said with justice that deaf-mutism is altogether so rare a pathological condition as to render it but seldom met with unless the enquiry embraces a large number of persons, consequently the number of marriages which produce two or more deaf-mute children in proportion to those which produce only one cannot be considered as slight.* It must also be borne in mind that the above statistics include deaf-mutes in general, among whom there are of necessity a great number with acquired deafness, and even among the congenital cases there are doubtless many where the deafness is owing to accidental causes. The percentage of marriages producing two or more deaf-mute children increases too, considerably, when the investigations only include cases of congenital deafness. Thus, WILHELMI found in the Government of Magdeburg that 54 (24 per cent.) of the 224 marriages which produced the congenital deaf-mutes examined by him resulted in two or more deaf-mute children [108, p. 76]. In Denmark the 226 deaf-mutes mentioned on p. 45 were the result of 197 marriages; of these, 61, *i.e.*, 31 per cent., produced two or more deaf-mute children. This figure is doubtless too low, as there was a possibility of children being born in many of the marriages after the investigations were made. Marriages which produce 4–10 deaf-mute children, although uncommon, are deserving of attention, as they prove that deaf-mutism, in spite of the rarity of its appearance, may be found with such overpowering frequency in certain marriages as to preclude any other explanation than the influence of inherited—though often mysterious—predisposition transmitted through the parents.

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* The Irish statistics only mention *congenital deaf-mutes*, while others embrace deaf-mutes in general; the distinction between congenital and acquired cases of deaf-mutes seems, however, in the Irish statistics, not to have been made everywhere, and the figures seem to point to their comprehending deaf-mutes in general.

† In Norway, UCHERMANN found that about 25 per cent. of these marriages produced more than one deaf-mute child [203, p. 99].

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* It may be stated for comparison, that although idiocy is twice as frequent in Denmark as deaf-mutism, there were in that country in 1888, out of 2,869 idiots, only 76 cases where two idiots were the result of one marriage, 13 cases with three, and only one with four [CARLSEN, 195, p. 53].

Another expression of the frequency with which several deaf-mute individuals are produced by the same parents, is arrived at by comparing the number of deaf and dumb children born in marriages which produce deaf-mutes, with the total number of children born in such unions. There are reports on this subject from Magdeburg [Wilhelmi, 108, p. 76], Saxony [H. Schmaltz, 161, p. 131], Mecklenburg-Schwerin [Lemcke, 210, p. 83], and Denmark. In this last country the 553 deaf-mutes mentioned [page 45] represented 514 marriages, which had produced 2,863 children, of whom 637 were deaf and dumb; this represents a fertility of about 5·6 children in each marriage, each fourth or fifth child being a deaf-mute. Wilhelmi in Magdeburg, and Lemcke in Mecklenburg-Schwerin, arrive at almost the same results, while H. Schmaltz, in Saxony, found a still greater fertility in the marriages which produce deaf and dumb children, and further, that only each fifth or sixth child was a deaf-mute. In Pommerania-Erfurt, Wilhelmi also found that marriages producing deaf-mutes were very fertile (5·9 children in each on an average). Wilhelmi's reports from Magdeburg and Pommerania-Erfurt only refer, however, to deaf-mutes with congenital deafness. If this group is considered alone in Denmark, it will be found that there were 226 congenital cases amongst the 553 deaf-mutes, representing 197 marriages. These had produced altogether 1,057 children, *i.e.*, on an average 5·4 in each; of these, 300 were deaf-mutes, showing that every third or fourth child born in these marriages was deaf and dumb. The 208 acquired cases represent 205 marriages with 1,159 children, of whom only 216 were deaf-mutes, *i.e.*, each fifth or sixth child. It may be observed, in connection with the above, that H. Schmaltz proved, that when two or more deaf-mutes are born in the same marriage, they generally suffer from congenital deafness [161, p. 138].

Although the above-mentioned circumstances concerning the appearance of deaf-mutism in individuals born of the same family prove, on closer investigation, to be principally the expression of certain peculiarities connected with congenital deafness, it must be observed, on the other hand, that acquired deafness may also attack two or more children belonging to the same family and cause deaf-mutism. For instance, H. Schmaltz found 16 marriages in Saxony, with two or more deaf and dumb children suffering from acquired deafness, *i.e.*, 1·2 per cent. of all the marriages which produced deaf-mutes [161, p. 138]. In Denmark, three of the above-mentioned 514 marriages were of this nature, which is about the same proportion as that found in Mecklenburg-Schwerin [210, p. 113]. The cause may naturally be supposed to be that epidemic diseases often attack several members of the same family. The following cases, taken from the reports mentioned (p. 45), seem to prove that this need not be purely accidental.

Cases Nos. 1 and 2. Ludwig B. married Marie J. in 1877, their respective ages being 33 and 21. There are two deaf-mute relatives in the husband's family, also some cases of insanity. Up to 1887, the marriage had produced four boys and two girls. Four of the children were attacked with cerebro-spinal meningitis at Christmas-time, 1887; the eldest, and youngest but one, became perfectly deaf, their ages being respectively nine and two, and have since lost the power of speech; the other children attacked became deaf in the one ear.

The following case is an example of acquired deafness appearing at different times among children born of the same parents without its apparently being accidental.

Cases Nos. 3-5. Martin M., cottager, and his wife, have had five children, of whom two died, aged respectively one and two years. A third child was born deaf. When the eldest but one, a boy born in 1881, was five years old, he lost his hearing in the course of a short time and without any apparent cause. This was also the case when the fourth child, a girl born in 1882, reached the same age. There is no deaf-mutism in the family, deafness, deficiency of hearing, or insanity, etc.

Congenital deafness and acquired deafness may also be present in the children of one family. H. SCHMALTZ mentions 13 such cases [161, p. 138], and LEMCKE, whose statistics embrace only about one-third as many deaf-mutes as SCHMALTZ, not less than nine [210, p. 113]. In Denmark there were eight such cases in the 514 marriages which produced the 553 deaf-mutes. I quote some of these cases because they are of great interest, pointing to the possibility of both congenital and acquired deafness being due to common remote causes.

Cases Nos. 6 and 7. Carl W. and Marianne S. had their first child when they were respectively 29 and 33 years old; this child hears and is perfectly healthy. The second child is believed with certainty to have heard until it had measles when over one year old; the measles were accompanied by severe inflammation of the ear and swelling behind both ears, resulting in the complete loss of hearing in the left ear, and such a considerable diminution in the hearing of the right ear as to necessitate the education of the child at a deaf and dumb asylum. Four children followed who can all hear. The seventh child, born when the father was 40, and the mother 44, has never shewn any signs of hearing and has never spoken, but is otherwise normal both bodily and mentally. The eighth child can hear. The parents are not related to each other, and there is nothing in the family history which can explain the deaf-mutism of these two children.

Cases 8 and 9. Kristen S. and Ane K. have altogether had nine children, of whom four are dead. The third child, a girl, born when the parents were both 31 years of age, could hear and speak until three years of age, when her hearing was so much reduced during whooping-cough, that it was necessary to send the child to a deaf and dumb asylum. The eighth child, born when the parents were 39, has never exhibited any signs of hearing, but has never been ill, and is otherwise normal both mentally and physically. The parents are not related to each other. Both husband and wife have a deaf-mute first cousin.

Cases 10 and 11. Hans K. and Dorthe A. have three children, all girls. The second, born when the parents were respectively 24 and 23, heard and spoke until she was two-and-a-half years old, when she had scarlet fever, resulting in total loss of hearing in the left ear and very considerable diminution of hearing in the right ear ; she has only spoken some few words since. The youngest, born when the parents were respectively 27 and 26 years of age, has never exhibited signs of hearing and never spoken. The parents are not related. The mother's sister is hard of hearing, but there is no case of deaf-mutism in the family.

There seems to be no rule as to the manner in which deaf-mutism appears among several children of the same marriage, as we have various combinations both as to sex and numerical position. This is proved by investigations in Denmark and by those of Sauveur, Lent, and Wilhelmi.

It is not to be wondered at that *twins* are sometimes deaf-mutes, since they are exposed to the same influences before birth. It is more remarkable that it is not rare for one twin to be born deaf, and the other with normal hearing. For instance, a deaf-mute couple in Denmark had twins, of whom the one, a girl, was born deaf, while the other, a boy, can hear.

Deaf-mutism in other Branches of the Deaf-mute's family.—Mygge has very closely examined the question of the appearance of deaf-mutism in the elder branches of the deaf-mute's family (cousins and second cousins not included). After criticising a number of statistics from deaf and dumb institutions in Belgium and Ireland, he found that of 7,482 deaf-mutes, 159 had, altogether, 157 deaf and dumb relations in the elder generations, exclusive of parents, *i.e.*, about every 47th deaf-mute. Of these relations, 99 were uncles or aunts, 36 great-uncles or great-aunts, 13 grand-parents, and nine of distant or uncertain degrees of relationship.

Table V. represents some investigations which Mygge had overlooked (from Cologne and Magdeburg); those which have appeared since the publication of that author's work; and the results obtained by examination of the 553 deaf-mutes in Denmark mentioned on p. 45.

Before drawing conclusions from Table V. it must be observed that the material upon which the different statistics is based varies greatly; for instance, different degrees of relationship are included in the different investigations, some of which refer to whole countries, others only to certain districts, &c. The calculations cannot, therefore, make pretension to absolute validity. The greater frequency of deaf-mutism in the collateral branches than in the direct ascending lines, can be partially explained by the greater number of individuals embraced by the former. This circumstance

TABLE V.—FREQUENCY OF DEAF-MUTISM AMONG RELATIVES OF DEAF-MUTES (PARENTS AND BROTHERS AND SISTERS NOT INCLUDED).

	Number of Deaf-mutes.	Corresponding Number of Families.	Number of Deaf-mutes with Deaf & Dumb Relatives.	Corresponding Number of Families.	Number of Deaf and Dumb Relations.						
					Grand-parents.	Great-uncles and Great-aunts.	Uncles and Aunts.	Uncles and Aunts of II. Degree.	First and Second Cousins.	Other or Uncertain Relatives.	Total.
Cologne, 1870 [101, p. 30]	382	338	34	26	0	2	8	2	8	14	34
Denmark, 1858–77 [122, p. 40]	327	292	34	27	1	4	5	0	19*	9	38
Saxony, 1880 [161, p. 141]	1,747	1,285	?	68	1	7	36		24	0	68
Mecklenburg, 1885 [210, p. 109]	533	475	?	42	0	1	24	0	38	0	63
Denmark, 1879–90 (*see* p. 45)	553	514	42	39	1	5	8	9	12	17	52
Total	3,542	2,904	?	202	3	19	92		101	40	255
Magdeburg, 1871 [108, p. 75]	284	?	22	18	0	4	3	5	8	8	28
Saxony, 1880 [161, p. 141]	671	?	?	47	0	5	23		19	0	47
Ireland, 1881 [149, p. 297]	3,092	?	?	193	6	4	59	0	107	0	176
Moos' Clinic [146, p. 301]	40	39	5	3	0	1	1	3	1	0	6
Würtemberg and Baden, 1880 [144, p. 192]	181	?	1	0	0	0	0	0	3	0	3
W. Meyer's Clinic, 1866–86 [189, p. 21]	54	50	4	4	0	0	3	1	0	0	4
Denmark, 1879–90 (*see* p. 45)	226	197	29	27	1	2	5	5	4	13	30
Total	4,548	?	?	292	7	16	108		142	21	294
Saxony, 1880 [161, p. 141]	685	?	?	20	1	1	13		5	0	20
Würtemberg and Baden, 1880 [144, p. 105]	321	?	0	0	0	0	0	0	0	0	0
Mecklenburg, 1885 [210, p. 108]	266	?	?	20	0	0	3	0	9	0	12
Denmark, 1879–90 (*see* p. 45)	208	205	9	9	0	2	1	4	4	3	14
Total	1,480	?	?	49	1	3	21		18	3	46

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* This figure includes "relatives of collateral or younger generations."

must also be remembered when considering the greater frequency with which deaf-mutism appears in different collateral branches.

In drawing comparisons between Table V. and Mygge's results, it must be remembered that the former includes first and second cousins, whose deaf-mutism may also be the result of influences inherited from older generations.

Certain main facts may, however, be deduced from the above table. To begin with, the circumstance that there was one deaf-mute relative (parents, and brothers and sisters not included) to every 16th deaf-mute, points to a greater frequency of deaf-mutism among the relatives of deaf-mutes than persons with normal hearing. It is true that there are no statistics referring to the number of deaf-mute relatives belonging to individuals with normal hearing, but there is no doubt that, as deaf-mutism is a comparatively rare pathological condition, it is not so common among the relatives of normal as of deaf-mute persons. Secondly, the slight difference existing between the rates found for deaf-mutes in general, and for congenital deaf-mutes in particular, is explained by the supposition that the frequency of deaf-mutism among the relatives of deaf-mutes is principally the result of certain peculiarities connected with congenital deafness. It has been proved that deaf-mutism is much less frequent among the relatives of deaf-mutes with acquired deafness. Table V. showed, further, that deaf-mutism is least frequent in the direct ascending line, more frequent in the collateral ascending lines—especially in the generations co-ordinate with the parents, and most frequent in the generations co-ordinate with the deaf-mute himself.* Finally, the investigators who have endeavoured to discover the cause of deaf-mutism among the deaf-mute relations, have proved that it was most frequently congenital deafness.

The following conclusions may be drawn from the facts laid down in pp. 46–60: Deaf-mutism is comparatively frequent among the relatives of deaf-mutes; it is least frequent in the direct ascending line (grand-parents, parents); more frequent in the collateral branches (great-uncles, great-aunts, uncles, aunts, grand-parents' cousins, parents' cousins, cousins, and second cousins); and most frequent by far among the brothers and sisters of the deaf-mute. This is in exact accordance with the result of an investigation into the appearance of deaf-mutism among the relations of congenital deaf-mutes [Mygind, 189, p. 26]; therefore, and from many of the facts above mentioned, we are justified in supposing that the manner in which deaf-mutism appears in different generations is a result of certain qualities appertaining to its congenital form.

EAR-DISEASES IN THE FAMILY OF THE DEAF-MUTE.—As post-mortem examinations of the auditory organs of deaf-mutes have proved that the deafness causing mutism is often the result of abnormalities in the ear, it is but natural to endeavour to find out how far ear-diseases, in the etiology of which heredity plays so important a part, can be proved to be frequent among the relations of deaf-mutes. All investigations have proved contrary to what might be expected, that ear-diseases, or rather their most common symptoms, complete and partial deafness, are comparatively rare among the relatives of deaf-mutes. Thus only 7 per cent. of the parents of congenital deaf-mutes who attended Dr. W. Meyer's clinic suffered from deficient hearing [189, p. 18], while v. Troeltsch declares (and he has never been contradicted) that every 3rd person between 20 and 50 years of age is more or less deaf at least in one ear. The percentage thus found is the highest yet published. Cases of ear-disease in other branches of the deaf-mute's family were found in Dr. Meyer's clinic to be still more rare, although less so than in other investigations [108, p. 75; 107, p. 414; 161, p. 141; 146, p. 201].

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* The small number of deaf-mute relations found in Denmark in the generations co-ordinate with the deaf-mute is explained by the circumstance that a great number of the individuals examined were very young, consequently the co-ordinate generations were also young and not numerous.

Ear-disease is still less frequent among the relatives of deaf-mutes in general. Of 1,591 deaf-mutes born in Saxony, H. Schmaltz only found 85 cases of deficient hearing among relatives [161, p. 147], *i.e.*, one case to every 20th deaf-mute. In Mecklenburg, Lemcke found 48 cases of deficient hearing among the relatives of 533 deaf-mutes, *i.e.*, one to every 11th deaf-mute. There were comparatively more cases of deficient hearing among the relatives of the 553 deaf-mutes mentioned p. 45, as shown in Table VI. In order to facilitate a comparison with H. Schmaltz' and Lemcke's tables, Table VI. has been drawn up in the same manner. It must, however, be borne in mind that the returns from Saxony embrace almost three times (1,591) as many deaf-mutes as those from Denmark and Mecklenburg-Schwerin, the figures for these two countries being very similar (553 and 533 deaf-mutes).

TABLE VI.—NUMBER OF DEAF (NOT DUMB) RELATIVES OF DEAF-MUTES IN SAXONY, MECKLENBURG-SCHWERIN, AND DENMARK.

		On the Father's Side.												On the Mother's Side								
		Grandfathers.	Grandmothers.	Great-uncles.	Great-aunts.	Uncles.	Aunts.	Cousins.	Total.	Fathers.	Mothers.	Brothers and Sisters.	Total.	Grandfathers.	Grandmothers.	Great-uncles.	Great-aunts.	Uncles.	Aunts.	Cousins.	Total.	TOTAL.
Congenital	Saxony	3	1	0	0	4	2	0	10	10	8	9	27	1	1	0	0	7	2	1	12	49
	Mecklenburg-Schwerin	0	0	0	0	1	0	1	2	1	1	10	12	1	0	0	0	0	0	2	3	17
	Denmark	7	4	1	0	5	2	1	20	6	12	15	33	8	7	2	0	3	6	2	28	81
	Total	10	5	1	0	10	4	2	32	17	21	34	72	10	8	2	0	10	8	5	43	147
Acquired	Saxony	2	0	0	0	1	3	0	6	4	3	7	14	2	3	0	0	3	2	1	11	31
	Mecklenburg-Schwerin	0	0	0	0	1	2	0	3	5	3	7	15	3	0	0	0	1	2	0	6	24
	Denmark	2	1	2	0	4	0	0	9	3	5	15	23	1	2	1	1	1	1	0	7	39
	Total	4	1	2	0	6	5	0	18	12	11	29	52	6	5	1	1	5	5	1	24	94
Uncertain	Saxony	0	0	0	0	0	0	0	0	1	1	3	5	0	0	0	0	0	0	0	0	5
	Mecklenburg-Schwerin	0	0	0	0	0	0	0	0	0	0	3	3	1	0	0	0	1	1	1	4	7
	Denmark	1	3	0	0	0	2	0	6	8	3	9	20	3	3	1	0	0	0	0	7	33
	Total	1	3	0	0	0	2	0	6	9	4	15	28	4	3	1	0	1	1	1	11	45
Deaf-mutes	Saxony	5	1	0	0	5	5	0	16	15	12	19	46	3	4	0	0	10	4	2	23	85
	Mecklenburg-Schwerin	0	0	0	0	2	2	1	5	6	4	20	30	5	0	0	0	2	3	3	13	48
	Denmark	10	8	3	0	9	4	1	35	17	20	39	76	12	12	4	1	4	7	2	42	153
	Total	15	9	3	0	16	11	2	56	38	36	78	152	20	16	4	1	16	14	7	78	286

So far as the 553 deaf-mutes in Denmark are concerned, it may be stated that the 153 individuals with deficient hearing or ear-disease were related to altogether 104 deaf-mutes (44 with congenital, 29 with acquired deafness, and 31 the origin of whose deafness was not stated), representing 90 families (33, 28 and 29 respectively).

It will be seen from Table VI. that ear-diseases were more frequent among the relatives of congenital deaf-mutes than of those with acquired deaf-mutism, both in Saxony and Denmark (in Denmark almost double). This is, perhaps, owing to the greater care with which ear-diseases have been sought for among the relations of congenital deaf-mutes. Lemcke found the reverse in Mecklenburg-Schwerin. This can be explained by the different manner in which the investigations in question were conducted. There is, in any case, reason to suppose that ear-diseases in the family are of importance also, so far as acquired deaf-mutism is concerned, since it is probable that an epidemic disease causing deaf-mutism in one member of a family, may in another produce ear-disease only resulting in deficient hearing, either because the process in the ear has been less destructive or only one-sided (compare cases 1 and 2, p. 56).

The following must be taken into consideration before forming any judgment as to the frequency with which ear-disease, or rather its symptoms, appear in the families of deaf-mutes. Deficient hearing is so common a symptom, that it would be certainly met with in a large number of the relatives of individuals with any abnormality, if made the subject of investigation. It is, therefore, remarkable that it is not more often found among the relatives of deaf-mutes than is the case. It is, however, difficult to prove the existence of ear-diseases by means of inquiries, partly because many symptoms of ear-disease, for instance discharge, easily escape notice, for it is often thought little of by the patient himself, and partly because the power of hearing must be much reduced before a person is declared by others, and still more, before he is declared by himself to be deaf. Besides which, one-sided deafness, even when considerable, easily escapes notice. There is, then, reason to consider the frequency with which ear-disease has been proved to exist among the relatives of deaf-mutes to be of great importance in elucidating the question of the influence of heredity upon deaf-mutism, since there is no doubt that, as a rule, only cases of very pronounced ear-disease are included in the investigations. So far as concerns the variable frequency with which ear-disease is found in the different branches of the deaf-mute's family, it must be remembered that deficient hearing and deafness in general cannot be proved in distant branches of a family as easily as in the more immediate relationships, and that symptoms of ear-disease, other than deaf-mutism, are the more difficult of discovery, the further they are removed in the family tree. It is, therefore, difficult to decide the importance due to the results obtained from Table VI., viz., that cases of deficient hearing, deafness, &c., occur more frequently in the direct ascending than in the collateral ascending lines, whilst it will be remembered that the opposite was the case as regards the occurrence of deaf-mutism in the deaf-mutes' family. It must then, for the present, remain an open question how far the diminished frequency of ear-disease in the older collateral branches is an expression of a lesser frequency of such abnormalities in these branches of the deaf-mute's family. The frequency of ear-disease among the deaf-mute's brothers and sisters must, however, be considered to be the result of an accumulation of cases of ear-disease in one generation. This is in entire accordance with the considerable number of cases of deaf-mutism found among the brothers and sisters of deaf-mutes. It is but natural to suppose that the conspicuous frequency with which deaf-mutism and deafness appear in one generation is the result of the same remote or more immediate causes, which sometimes give rise to ear troubles of less pronounced character or appearing later, and sometimes to more pronounced congenital or acquired abnormalities of the ears resulting in deaf-mutism.

It will be seen from Table VI. that ear-diseases are much more frequent in the female line than in the male. The explanation may be that deaf-mutism attacks males more frequently than females, and it is a well-known fact that boys are more inclined to inherit pathological and physiological peculiarities from their mothers than from their fathers.

Having thus brought forward a number of circumstances relating to the appearance of deaf-mutism and ear-disease among the relatives of deaf-mutes, I will proceed in the following pages to draw attention to the appearance of other abnormalities, more remotely connected with deaf-mutism, among the deaf-mutes' relations, including anomalities and diseases which do not appear *a priori* to be connected with deaf-mutism, but which are so frequent in the families of deaf-mutes as to lead to the supposition of some existing connection between them and that abnormality.

INSANITY IN THE FAMILY OF THE DEAF-MUTE.—Sauveur found from the Belgian census of 1835, that about 5 per cent. of the deaf-mutes in Belgium suffered from "*idiotisme ou aliénation mentale*" [67, p. 29]. It was, therefore, natural to suppose that there was a relationship between these two abnormalities, due not only to more immediate causes—especially acute brain-diseases—but also to others more remote, and that consequently there would be found a certain frequency of idiocy and insanity in the relatives of deaf-mutes.* Since Sauveur's work, however, but little has been written upon this subject, and most investigations have given but poor results. Lemcke's, in Mecklenburg-Schwerin, form an exception. This author found in 33 of 405 families which produced deaf-mute children, *i.e.*, in 8 per cent. of the cases, one or more relation—altogether 42—with insanity [210, p. 124]. This result is very much the same as that found for the 553 Danish deaf-mutes mentioned on p. 45, as there were relatives with insanity in 36 of the 514 families, *i.e.*, in 7 per cent. Lemcke found a greater number of cases of insanity among the deaf-mutes' brothers and sisters, the reason being that he dealt with deaf-mutes of all ages, while the Danish statistics refer principally to children and young persons.

Table VII. shows a greater frequency of insanity among the relatives in the ascending collateral, and a

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* There is, perhaps, another connection between deaf-mutism and brain-disease, viz., that the latter may be the result of the former. This will be entered into more fully when discussing the sequelæ of deaf-mutism.

TABLE VII.—INSANITY, EPILEPSY, IDIOCY, &C., AMONG RELATIVES OF DEAF-MUTES IN DENMARK.

	Number of Deaf-mutes.	Number of Families.	Number of Abnormal Relatives.											
			Parents.	Uncles and Aunts.	Parents' Cousins.	Grandparents.	Great-uncles and Great-aunts.	Grandparents' Cousins	Great-grandparents.	Brothers and Sisters.	Cousins.	Other Relatives.	Total.	
Congenital	23	20	5	7	0	4	7	0	1	0	0	1	25	Insanity.
Acquired .	12	12	3	3	0	0	4	0	0	0	0	2	12	
Uncertain .	4	4	0	1	1	1	1	0	0	0	0	0	4	
Total .	39	36	8	11	1	5	12	0	1	0	0	3	41	
Congenital	20	16	4	6	0	3	0	0	0	2	1	1	17	Epilepsy.
Acquired .	10	10	5	4	0	2	0	0	0	1	1	0	13	
Uncertain .	10	10	5	3	0	4	0	0	0	0	0	0	12	
Total .	40	36	14	13	0	9	0	0	0	3	2	1	42	
Congenital	20	13	3	4	1	2	1	0	1	5	2	1	20	Idiocy.
Acquired .	4	4	0	1	1	0	0	0	0	2	0	0	4	
Uncertain .	2	2	1	1	0	0	0	0	0	0	0	0	2	
Total .	26	19	4	6	2	2	1	0	1	7	2	1	26	
Congenital	14	12	4	4	1	0	0	1	0	4	0	1	15	Defects of Speech.
Acquired .	6	6	2	0	0	0	0	0	0	4	0	0	6	
Uncertain .	6	6	0	3	2	1	0	0	0	1	0	0	7	
Total .	26	24	6	7	3	1	0	1	0	9	0	1	28	
Congenital	15	14	14	6	0	0	0	1	0	1	1	2	25	Other Nervous Disorders.
Acquired .	9	9	5	2	0	2	0	0	0	0	0	0	9	
Uncertain .	5	5	2	0	1	2	0	0	0	0	0	0	5	
Total .	29	28	21	8	1	4	0	1	0	1	1	2	39	
TOTAL .	129*	117	53	45	7	21	13	2	2	20	5	8	176	

* The total sum is smaller than the sum of all the figures of this column on account of several deaf-mutes in the different sections being brothers and sisters.

lesser in the direct ascending line, but since there are fewer individuals in the latter no conclusion can be drawn from the figures as to which branch of the deaf-mute's family is most heavily burdened with insanity. As, however, we know with certainty the number of parents and grand-parents corresponding to the 553 Danish deaf-mutes (1,028 and 2,056 respectively), it may be observed that 0·8 per cent. of the parents, and only 0·2 per cent. of the grand-parents, suffered from insanity. These figures bear a close resemblance to LEMCKE's, which were 0·9 and 0·2 respectively. As about 0·2 per cent. of the Danish population between 20–40 years of age suffer from insanity [154, p. cxiv.], and as the majority of the parents of deaf-mutes belonged to this period of age at the time of the investigations, there is reason to suppose that insanity is more common among the parents of deaf-mutes than among individuals in general of the same age. On the other hand, insanity cannot be considered to be particularly frequent among the grand-parents of deaf-mutes, since it appears, in Denmark, in about 0·3 per cent. of the older population (the period of age over 60).

The appearance of insanity among the relations of deaf-mutes is still more evident when the deaf-mutes included in Table VII. are divided into three groups, according to the origin of their deafness. We shall then find that insanity is almost twice as frequent in Denmark among the relations of congenital deaf-mutes as it is among the relations of those with acquired deafness. Insanity seems to be particularly frequent among the parents of congenital deaf-mutes, a comparison between such persons and individuals in general of the same age showing that this abnormality is six times as frequent in the former as in the latter. Lemcke, however, could find no difference between the frequency of insanity in the relations of congenital deaf-mutes and in those with acquired deaf-mutism [210, p. 124]. This seems to indicate the importance of insanity in the family of individuals with acquired deaf-mutism also. This is not to be wondered at, as infantile deafness may be the result of acute brain-disease, between which and chronic brain-disease there is no reason to doubt a relationship. A closer investigation of the causes of deafness in the 12 deaf-mutes with acquired deafness, in whose families there were cases of insanity, does not, however, support this hypothesis, only 5 of these being deaf as the result of acute brain-disease. This frequency is not remarkable, (compare the section on acute brain-disease as a cause of deaf-mutism).

EPILEPSY IN THE FAMILY OF THE DEAF-MUTE.—There is but little mention made in literature of epilepsy and similar brain-diseases appearing with convulsions among the relations of deaf-mutes. It must, however, be mentioned, that Sauveur found that about 1 per cent. of the Belgian deaf-mutes were sufferers from epilepsy [67, p. 29]. According to Table VII., epilepsy and other brain-diseases combined with convulsions, appear in the families of deaf-mutes with about the same frequency as insanity. Further, almost twice as many congenital deaf-mutes as others with acquired deafness had relatives with epilepsy, but the number of such relatives did not differ greatly in the two groups, indicating the importance of epilepsy and similar diseases in the family in the appearance of acquired deafness. This supposition is supported by the circumstance that of the 10 cases of acquired deafness 7 were the result of acute brain-disease.

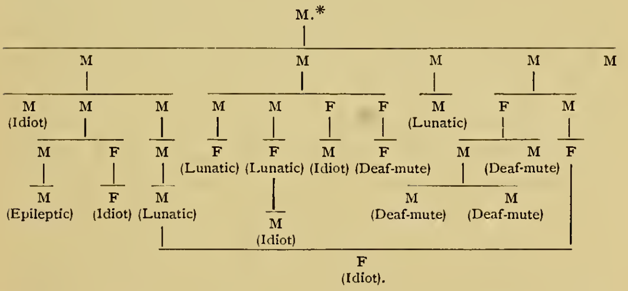
It is difficult to draw any conclusions as to the frequency with which epilepsy and similar diseases appear among the relatives of deaf-mutes, since we have no information as to their appearance among individuals in general. As, however, 1·2 per cent. of the parents of deaf-mutes suffered from such abnormalities, there is reason to suppose that these diseases are comparatively frequent, at least among the parents.

IDIOCY IN THE FAMILY OF THE DEAF-MUTE.—According to Table VII., idiocy, under which heading are included imbecility, feeble-mindedness, &c., is not so frequent among the relatives of deaf-mutes as the previously-mentioned abnormalities. J. Carlsen's investigations prove that there were at least as many idiots as lunatics in Denmark [195, p. 17], consequently we can but suppose that idiocy among relatives plays a less important part, so far as deaf-mutism in general is concerned. It will be seen, however, that it is among the relatives of deaf-mutes with acquired deafness that idiocy, &c., is comparatively rare, while among the relatives of individuals with congenital deafness it is as frequent as insanity.

SIMULTANEOUS APPEARANCE OF INSANITY, EPILEPSY, AND IDIOCY IN THE FAMILY OF THE DEAF-MUTE.—The Danish reports give several instances of this, among which is the following :—

Cases 12 and 14. Anders J., cottager, and Bodil O. were married in 1868, at the respective ages of 28 and 23. They were not related. The wife's mother has a very deficient intellect, another daughter suffers from epilepsy and is idiotic. Up to 1883, the marriage had produced five children, three boys and two girls ; of these, the eldest, a girl, was born deaf ; the second, a boy, is very deaf, but can attend an ordinary school, though obliged to sit near the teacher ; the third, a boy, was born deaf ; the fourth, a girl, is idiotic and paretic with staggering gait and indistinct utterance, also somewhat deaf ; the fifth, a boy, was born deaf, but is lively and intelligent.

Dahl's genealogical tables of certain Norwegian families give the most striking examples of the simultaneous appearance of insanity, epilepsy, and idiocy among the relatives of deaf-mutes. The following is especially worthy of notice [85, p. 80] :—



It will be seen that this family included 34 individuals, of whom four were deaf-mutes, four insane, five idiots, and one epileptic. This table is of great interest, as it shows how the different abnormalities alternate with each other in the different generations, passing entirely over some and accumulating in others.

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* M = male ; F = female.

STAMMERING AND OTHER DEFECTS OF SPEECH IN THE FAMILY OF THE DEAF-MUTE.—Investigations as to the appearance of stammering, stuttering, and similar defects of speech, among the relatives of deaf-mutes, cannot fail to be of interest, as these abnormalities are doubtless the expression of nervous disease, and, like deaf-mutism, are most frequent in males, besides being greatly influenced by hereditary peculiarities. According to Table VII. they appear with almost exactly the same frequency as idiocy. We have, however, no information concerning their frequency in individuals in general; still there is little reason to doubt that they are particularly common in the relatives of deaf-mutes, especially congenital deaf-mutes.

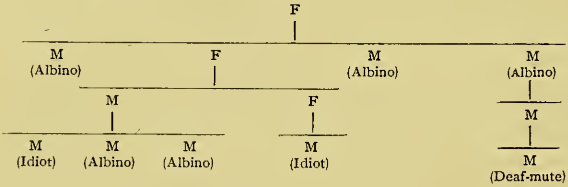
OTHER NERVOUS DISEASES IN THE FAMILY OF THE DEAF-MUTE.—This last group of abnormalities, mentioned in Table VII., includes hysteria, especially in the female parents, and other diseases described for instance, as "nervousness," "nervous disease," "brain-disease," &c. These complaints were also most frequent among the relatives of congenital deaf-mutes. That they also are of importance in the families of deaf-mutes with acquired deafness can be seen from the circumstance that of the nine cases of acquired deaf-mutism seven were the result of acute brain-disease.—

My reasons for having dealt more fully with the results of Table VII., although the statistical material on which it is based is not very extensive, are the following: First, because this very limited nature of the material made a survey all the more easy.

Secondly, because these investigations have this great advantage—that each single report of a deaf-mute is filled in by a medical man, thus guaranteeing a correct comprehension of each question and its conscientious answer. Thirdly, the majority of the reports were drawn up before the deaf-mutes were eight years old, and many still earlier. This must of course tend to increase their accuracy, but has, on the other hand, the disadvantage that the number of relatives suffering from deaf-mutism, insanity, &c., is too small. I have, however, corrected this by other means, especially by making use of the reports of deaf-mutes "previously reported" (*see* p. 44) to obtain information as to abnormalities which appeared in the family at a later period, &c. I cannot, therefore, think otherwise than that the results thus obtained are deserving of attention, for although not entirely new, still they appear in a clearer light, and I hope will give occasion for more extensive researches in the direction indicated.

CRETINISM AND STRUMA (GOITRE) IN THE FAMILY OF THE DEAF-MUTE.—Bircher has touched upon this subject, and has proved that the endemic form of deaf-mutism which prevails in Switzerland is most frequent in that country in places where struma and the cretinic degeneration related to it are most intense [158, p. 78]. Bircher is, however, of opinion that heredity, *i.e.*, struma in the ascending line, is only a predisposing factor, but that it is territorial conditions which cause the more severe forms of cretinic degeneration, among which he reckons deaf-mutism. The endemic deaf-mutism which appears in Switzerland may, however, be a peculiar form of this abnormality, differing from that treated of here, and in this way we can explain the relationship which Swiss authors declare to exist between cretinism and struma on the one hand, and deaf-mutism on the other.

ALBINISM IN THE FAMILY OF THE DEAF-MUTE.—Although Wilhelmi believed that deaf-mutism and albinism have nothing to do with each other, and could not find a single deaf-mute with this abnormality [108, p. 75], there is no reason to contradict Dahl, who, in his exhaustive work on insanity in Norway, is of opinion that a morbid tendency in a family may produce sometimes insanity, sometimes idiocy, sometimes deaf-mutism, and sometimes albinism, in different members. The relation between albinism and deaf-mutism is especially evident in the following family reported by Dahl [85, p. 87]:



MALFORMATIONS IN THE FAMILY OF THE DEAF-MUTE.—No mention is made in literature of malformations among the relatives of deaf-mutes. As such abnormalities seem to be more frequent among deaf-mutes than in individuals in general, there is reason to investigate the frequency of their appearance among the relatives of deaf-mutes. There were three cases among the relatives of the 226 congenital deaf-mutes in Denmark. One deaf-mute had a paternal aunt with cleft palate, a second had a deceased brother born hemicephalic, of a third it was stated that his mother's step-brother's son had a deformed ear. None of the relatives of the other deaf-mutes suffered from malformations.

RETINITIS PIGMENTOSA IN THE FAMILY OF THE DEAF-MUTE.—H. SCHMALTZ found seven cases of this disorder among the relatives of 1,591 deaf-mutes [161, p. 148]. LEMCKE, in Mecklenburg-Schwerin, found it still more frequently, viz., in 12 relatives, corresponding to 553 deaf-mutes [210, p. 121]. As the Danish reports contain no column referring to this matter they yield no information on the subject. Future investigations will doubtless prove the constant appearance of retinitis pigmentosa in the relatives of deaf-mutes, as the two abnormalities are closely related to each other.

TUBERCULOSIS IN THE FAMILY OF THE DEAF-MUTE.—LEMCKE found tuberculosis to be in all probability somewhat frequent among the relatives of deaf-mutes in Mecklenburg-Schwerin [210, p. 122]. Should this be confirmed by future investigations, the explanation is doubtless to be sought in the unfavourable hygienic and social conditions under which the relatives of deaf-mutes live as a rule.

THEORY AS TO THE HEREDITY OF DEAF-MUTISM.—Having brought forward a series of facts referring to the appearance of deaf-mutism and other pathological conditions among the relatives of deaf-mutes, it may not be out of place to enquire whether these facts cannot be brought under definite laws concerning the heredity of deaf-mutism.

The statements made p. 46 and following, do not at first sight, speak much in favour of the heredity of deaf-mutism, that is, if the term heredity is used to express the frequent appearance of the same pathological condition in two consecutive generations. It was found, namely, that the frequency with which deaf-mutism appears in two consecutive generations is not considerable. If, however, we take into consideration (1) that deaf-mutism on the whole is a rare abnormality, (2) that deaf-mutes marry comparatively seldom, (3) that such marriages produce few children (p. 49), and (4) that the majority of investigations include both deaf-mutes with congenital deafness and those with acquired deafness, we must of necessity see the matter in a somewhat different light, and, having corrected our standard by these considerations, we cannot but suppose that deaf-mutism appears with such frequency in two consecutive generations that it must be considered to be an abnormality which is greatly influenced by direct transmission, though not to the same extent as many others.

If, however, the term heredity is used to express the greater frequency of the same abnormality in a certain family, then the hereditability of deaf-mutism becomes more evident. It has, for instance, been proved (p. 46 and following) that deaf-mutism is particularly frequent among the relatives of deaf-mutes, especially in the collateral branches, and this frequency is the more remarkable since deaf-mutism is, as has been so often pointed out, a comparatively rare abnormality. There is reason to lay especial stress upon the decided inclination which deaf-mutism shows to appear in two or more children of the same parents, for, while the greater frequency of deaf-mutism in the collateral branches can be explained by the circumstance that these of necessity embrace a larger number of individuals than the direct ascending lines, our knowledge of the number of the deaf-mute's brothers and sisters furnishes us with a reliable standard by which to judge of the frequency with which deaf-mutism appears among the children of the same parents. It would be purposeless to argue whether the appearance of deaf-mutism here described is to be termed the result of indirect transmission, or whether the expressions, family peculiarity, family tendency, and suchlike, may be used, or whether we should give the preference to the more inclusive term : heredity. None of these expressions hit the mark, nor do they give a satisfactory explanation of the remarkable circumstance that an abnormality can entirely pass over one or more generations.

Finally, if by heredity we understand the frequent appearance in a family of not only one pathological condition but of several others related to it, we shall be forced to admit that heredity is a most important factor in the etiology of deaf-mutism. The facts laid down, p. 62 and following, prove that partial and total deafness, insanity, epilepsy, idiocy, and some few other abnormalities, are so frequent in the families of deaf-mutes, especially of those with congenital deafness, as to entirely exclude the possibility of this being the result of accidental circumstances.

The laws which may, then, be supposed to regulate the heredity of deaf-mutism are difficult of interpretation, and seem in many respects to differ from those which relate to other pathological conditions and diseases. This may be accounted for by supposing that as the causes of deaf-mutism in general are numerous and various, so are also the causes of each individual case. The circumstance that deaf-mutism, so far as its etiology is concerned, must be divided into two distinct classes, the congenital and the acquired, the latter of necessity including numerous cases in which deafness is traced to accidental causes, is alone sufficient to render the interpretation of the laws of heredity, by the help of investigations which embrace deaf-mutes in general, of the greatest difficulty. When we add to this, that although the importance of heredity in deaf-mutism is undoubted and considerable, there are other factors of at least equal importance, and that there is much which tends to neutralize the transmission of morbid tendencies, (favourable social conditions, crossed marriages, &c.,) it will be evident that there is much which renders a just explanation of the laws of heredity anything but an easy task. If we compare deaf-mutism with hemophilia, which it resembles so far as heredity is concerned, we shall see how correct the above statements are. Hemophilia—which, like deaf-mutism, may pass over several generations and accumulate in a single one, being also most frequent among males, and in the children of fruitful marriages—is, etiologically, but little complicated, partly because it is not related to any other anomaly, and partly because heredity is the governing cause. With deaf-mutism it is very different. It, too, may accumulate in single generations, being most frequent in brothers and sisters, and much less frequent in the older generations. In these, however, there can be found a comparatively large number of cases of partial or total deafness, insanity, epilepsy, &c., which seems to indicate that deaf-mutism in many instances is a *combined result* of the transmission of *various influences*. These influences fall into two groups—those which originate in *ear-diseases*, and those which originate in *nervous diseases* in the family. Now, as the morbid anatomy of deaf-mutism proves that in the majority of cases the deafness causing deaf-mutism arises from abnormalities of the nervous parts of the auditory organ—the labyrinth—there is reason to suppose that in many cases deaf-mutism is caused by the transmission of the above-mentioned dual influences through the parents. Supposing this hypothesis to be correct, our knowledge of the laws of heredity in deaf-mutism assumes at once a more distinct form, though we cannot ever expect it to be as clear as it is for instance in regard to the laws which govern hemophilia, for, as above mentioned, the causes of deaf-mutism are too numerous and varied. Even twins, who would seem to be exposed to exactly the same influences during fœtal life, are sometimes the one a deaf-mute, the other a normal subject. As examples of the appearance of deaf-mutism among the children of persons in whose family there was ear-disease as well as insanity, epilepsy, idiocy, &c., the following may be quoted, besides several interesting genealogical tables given by Dahl [85].

Cases Nos. 15–17. Niels A., a tailor, and his wife were not related. Both were 21 years of age when married. Several of the husband's first-cousins are partially deaf, and one is insane.

The wife's brother's son has been very deaf from birth. The husband is inclined to drink. Seven children have been born of this marriage, four boys and three girls; of these Nos. 1, 5, and 7 are congenital deaf-mutes.

Case 18. Jens R., labourer, was married when 22 years of age to a woman 32 years of age, who, a few weeks after, gave birth to their first child, a son, whose external ear and external auditory meatus was wanting on either side. He cannot hear anything except a few words shouted very loud, and can only say a few words. The wife has since had two abortions, in the sixth and third months of pregnancy; she has very deficient powers of intellect; her step-brother's son has a remarkably small ear and deficient hearing; her brother is very deaf; a distant relative is idiotic and epileptic.

Cases Nos. 19–21. Jens O. and Inger J. were, at the time of their marriage, 23 and 19 years of age. They are not related. The wife is of a melancholy disposition; her brother and mother's sister are both insane. The husband is deaf in one ear, in which he now and then suffers severe pain, but has no discharge; his sister has a cleft palate. There are five children of this marriage, three boys and two girls, and, of these, Nos. 2, 3, and 4 are congenital deaf-mutes.

Case No. 22. Daniel L. and Else J., not related, were respectively 33 and 23 at marriage. The husband's father is very deaf, and he himself has been partially deaf for several years, and has for some time been given to drink. The wife is of inferior intellect. There are of this marriage seven children, of whom the eldest has been partially deaf from birth, which was also the case with No. 6, whose hearing became much worse after diphtheria. The youngest child, a boy, is a congenital deaf-mute.

Case No. 23. Jens M. and wife were married when respectively 21 and 18 years of age. The husband suffered from epileptic fits from 11–18 years of age, but has since only had a few attacks. The wife's mother's sister was insane after delivery, and is very deaf. This marriage has produced two girls and two boys. The eldest, a boy, lost his hearing entirely when five years old, the result of a brain-disease with typhoid symptoms; the youngest, also a boy, suffers from discharge from the ear and partial deafness.

These instances of marriages in which the transmission of various pathological influences through the parents has resulted in deaf-mutism, all exhibit a remarkably large number of cases of deaf-mutism and partial deafness among the children born of them. The following proves that this is not accidental. Of the 197 marriages of which the 226 deaf-mutes in Denmark were born, those in which only ear-disease (deaf-mutism not included), only deaf-mutism, or only nervous disease, were found among the relatives, produced on an average 1·5 deaf-mute child each, and about every fourth child born of these marriages was deaf-mute. In marriages where there were cases of deaf-mutism and also of nervous disease among the relatives, there were, on an average, not less than two deaf-mute children in each, and every third child was deaf-mute.

This seems to support the hypothesis above laid down, viz., that deaf-mutism may be influenced, not only by other cases of deaf-mutism in the family, but also by ear-disease and certain forms of nervous disease. It must, however, be pointed out that the statistics on which these investigations are based must not be considered as entirely reliable, partly because they embrace a comparatively small number of cases, and partly from causes mentioned above. It remains for future investigations to produce a broader and more solid foundation on which to build up a clearer knowledge of the laws which govern the heredity of deaf-mutism.

CONSANGUINITY.—The question of the importance of consanguinity as a cause of deaf-mutism has been a fruitful subject of discussion. The first decidedly expressed opinion upon this topic appeared in 1846, when MENIÈRE [63, p. 225, see also 77] and PUYBONNIEUX [64, p. 12], who were respectively medical attendant and teacher at the Imperial Deaf and Dumb Institution in Paris, laid great stress upon the important part which consanguinity played in deaf-mutism, without, however, producing statistics in support of their theory. Such, however, appeared shortly after in returns of the Irish census of 1851, which was the first to include this question in its rubrics, and from the results thus obtained, WILDE came to the conclusion that "among the predisposing causes of muteism, the too close consanguinity of parents may be looked upon as paramount" [72, p. 470]. RILLIET, LANDES, CHAZARAIN, BEMISS, HOWE, DAHL, BOUDIN, MITCHELL, and the undaunted defender of the doctrine of consanguinity, DEVAY, were all in favour of the importance of this factor in the etiology of deaf-mutism [131, p. 11 and following], whilst BOURGEOIS, PERIER, HUTH, VOISIN and G. DARWIN were more or less opposed to the hypothesis that consanguineous marriages predispose to degeneration in the offspring, deaf-mutism being generally the principal object of their arguments. Statistical information as to the frequency of consanguinity among the parents of deaf-mutes has also been forthcoming. For information as to the latter, readers can refer to Table VIII.

Space does not permit me to go more closely into the extensive literature which has appeared upon the subject of the importance of consanguinity in the etiology of deaf-mutism. There is less reason to do so since J. MYGGE, in his exhaustive work on consan-

TABLE VIII.—FREQUENCY WITH WHICH DEAF-MUTES ARE REPORTED AS HAVING BEEN BORN OF CONSANGUINEOUS MARRIAGES.

	Deaf-mutes.			Congenital Deaf-mutes.		
	Total Number.	Born of Consanguineous Marriages.	Per cent.	Total Number.	Born of Consanguineous Marriages.	Per cent.
Nassau, 1864 [Meckel, *see* 132, p. 65]	381	31	8·1	228	31	13·6
Breslau, 1869 [Cohn and Bergmann, 100, p. 4]	130	11	8·5	57	9	15·8
Cologne, 1869 [Lent, 101, p. 32]	370	13	3·5	166	8	4·8
Magdeburg, 1871 [Wilhelmi, 108, pp. 72 and 81]	519	35	6·7	284	27	9·5
Berlin, 1872 [Falk, 107, p. 419]	—	—	—	69	7	10·2
Pomerania, 1875 [Wilhelmi and Hartmann, 134, p. 314]	1,637	105	6·4	592	106	17·9
Erfurt, 1875 [*ibid*]	325	12	3·7	168	10	5·9
Berlin, 1877 [Hartmann, 118, p. 574]	185	8	4·3	45	8	17·7
Breslau, 1869–79 [Bergmann, 125, p. 40]	270	17	6·3	80	12	15·0
Ireland, 1881 [Census, 149, p. 43]	3,845	219	5·7	3,092	213	6·9
Baden and Würtemberg, 1882 [Hedinger, 144, p. 118]	415	5	1·6	181	5	2·8
Moos' Clinic, 1882 [Moos, 146, p. 308]	—	—	—	40	13	32·5
Saxony, 1884 [Schmaltz, 161, p. 136]	1,591	34	2·1	671	23	3·4
Mecklenburg, 1885 [Lemcke, 210, p. 97]	533	37	6·9	217	28	12·9
Norway, 1885 [Uchermann, 203, p. 99]	—	—	—	933	214	23·0
Meyer's Clinic, 1868-88 [Mygind, 189, p. 35]	210	19	9·0	54	12	22·2
England, 1889 [Royal Commission, 181, p. li.]	2,485	99	3·9	—	—	—
Denmark, 1879–90 (*see* p. 45)	553	52	9·4	226	33	14·6

guinity, has subjected all that had appeared up to 1879 to a most critical examination, some few works only being omitted [Lent 101, Wilhelmi 108, and Hartmann 118]. Even with these, and with what has appeared since Mygge's book was published, the results would differ but little from those arrived at by this author. As this valuable work has been almost unnoticed out of Scandinavia, I will, in the following pages, shortly review some of its main features.

Mygge first subjects the various works on consanguinity to an exhaustive criticism, and points out their various deficiencies, which are principally owing to their being founded on unreliable statistics or purely theoretical considerations. This criticism is, and rightly so, particularly directed against the works of Devay and Boudin, both warm defenders of the doctrine of consanguinity. Mygge proceeds to prove, that the question as to the importance of consanguinity can only be solved by an objective valuation of methodically drawn-up statistics. This can be done in two ways. The first is to collect a number of consanguineous and crossed marriages, and to examine into the condition of the children produced in them. The second is to take a large group of individuals suffering from certain abnormalities and to discover how many of them are born of consanguineous or crossed marriages. Using the first method as a basis, Mygge collected information from numerous rural districts in Denmark, which he subjected to statistical revision, and came to the conclusion that the issue of consanguineous marriages were absolutely more exposed to idiocy, insanity and other psychological defects than other persons, whilst there was a doubtful preponderance with regard to defects of hearing [131, p. 162]. By the aid of the second of the above-mentioned methods, and by using deaf-mutism as the basis for his investigations (that abnormality having most frequently been placed in connection with consanguineous marriages), and also by comparisons with the results of an investigation into the frequency of consanguineous marriages, Mygge arrived at the following results: While in Denmark consanguineous marriages may be supposed to represent about 3–4 per cent. of all marriages, 6·75 per cent. of the deaf-mutes admitted into the Royal Deaf and Dumb Institution in Copenhagen, between 1858 and 1877 (altogether 477), were the result of such marriages. If the congenital deaf-mutes were considered alone, the result was that 7·55 were born of consanguineous marriages. On comparing these results with others which have appeared in literature, Mygge considered himself authorized to lay down the following conclusion:—There are a comparatively greater number of deaf-mutes among the children of consanguineous than of crossed marriages, while, on the other hand, it is certain that the former do not play such an important part in the etiology of deaf-mutism as is supposed by Boudin, since the chance of having deaf-mute children cannot be supposed to be more than about twice or four times as great for persons who are blood relations as for persons who are not related, at least not nearer than the seventh degree.

Since Mygge's book was published numerous statements have been made as to the frequency with which deaf-mutes are produced in consanguineous marriages. These, and some omitted by Mygge, are given in

Table VIII., in which is included the number of deaf-mutes born of consanguineous marriages.

It will be seen from Table VIII. that the more recent statements as to the frequency with which deaf-mutes are born of consanguineous marriages differ considerably from each other. This can most naturally be explained as resulting from various circumstances. To begin with, such marriages vary in frequency in different countries; thus, in Prussia they form 0·8 per cent. of all marriages [Wilhelmi, Hartmann, 134, p. 328], in France 1–2, and in England 3 per cent. at the outside [Mygge, 131, p. 206], and in Denmark 3–4 per cent. [*ibid* p. 212], and in Saxony 4 per cent. [Schmaltz, 161, p. 136]. Further, there is no doubt that the frequency of consanguineous marriages differs in the different creeds and classes of society, and possibly also in different districts. It must also be observed that the various statistics sometimes embrace whole countries, sometimes single districts, sometimes deaf and dumb institutions, clinics, &c. The information in question has also been obtained in different ways; for instance, by reports, censuses, individual investigations, &c., and, finally, the different authors have included different degrees of relationship.

Although many investigators have found comparatively few deaf-mutes born of consanguineous marriages, there are several circumstances which seem to prove that consanguinity is an important factor in the etiology of deaf-mutism. They are the following:

(1.) Several of the reports contained in Table VIII.—and not a few earlier ones, the reliability of which cannot be doubted—are to the effect that deaf-mutes are comparatively often born of consanguineous marriages, and there seems to be reason to lay greater stress upon such positive results than upon those pointing in a negative direction.

(2.) All authors are unanimous in declaring consanguineous origin to be more common among congenital deaf-mutes than among deaf-mutes in general. This indicates that it is deaf-mutes with acquired deafness who reduce the rate that expresses the frequency with which deaf-mutes in general are born in consanguineous marriages. Table VIII. shows also that a large proportion of the statistics it includes are to the effect that a very considerable number of congenital deaf-mutes are the result of marriages between blood-relations. Thus, while among the 553 Danish deaf-mutes (whose classification into congenital deaf-mutes and those whose deafness was acquired cannot be said to have been influenced by preconceived notions of the importance of consanguinity in congenital deafness) only 3·3 per cent. of those with acquired deaf-mutism were born of consanguineous marriages (marriages between second cousins included), while this was the case with 14·6 of the congenital cases. That consanguinity plays a part in congenital deafness, only, or almost only, may be seen from the circumstance that all authors who have occupied themselves with this subject have come to the result that deaf-mute children born of consanguineous marriages are in the majority of cases born deaf, while only a small minority become deaf after birth [Mygind, 189, Table III., Irish census of 1881, 149, p. 43, Lemcke, 210, p. 99]. In connection with the above it may be mentioned that the 33 Danish *congenital* deaf-mutes, mentioned in Table VIII., were born in 28 marriages, with an average of 1·89 deaf and dumb child in each (*see* below), while the remaining 19 deaf-mutes were born of consanguineous marriages with one deaf and dumb child in each.

(3.) That consanguinity is of importance in the etiology of deaf-mutism is evident from the circumstance that several authors have proved that among the marriages of which deaf-mutes are born, the consanguineous unions produce a larger number than the crossed. Thus, in Ireland, in 1881, on the average 1·62 deaf-mute child was found as the result of every consanguineous union, and only 1·30 in every crossed marriage [149, p. 43]. In Magdeburg, Wilhelmi found on an average 1·26 deaf-mute child in every crossed, and 1·71 deaf-mute child in every consanguineous marriage [108, p. 73 and 76]; in Dr. W. Meyer's clinic in Copenhagen, the figures were respectively 1·34 and 1·75 [189, p. 37]. The 52 Danish deaf-mutes, mentioned in Table VIII., were born of 47 marriages in which the parents were related; these marriages produced 72 deaf and dumb children, *i.e.*, on an average 1·53 in each, whilst there were 558 deaf and dumb children in the remaining 467 crossed marriages, *i.e.*, on an average 1·20 in each.

(4.) Other circumstances in connection with consanguineous marriages producing deaf-mutes speak strongly against the possibility of the relation between such marriages and deaf-mutism being accidental. For instance, Wilhelmi and Lemcke found respectively that only 36 and 41 per cent. of the children born in such marriages were alive and normal at the time of their investigations [108, p. 73 and 210, p. 100]. The Danish statistics give a similar result, since only 162 of the 282 children born of the 47 consanguineous marriages, to which the 52 deaf-mutes mentioned in Table VIII. belonged, were alive and without any defect.* The considerable mortality which was found by LEMCKE and also in Denmark among children born of consanguineous marriages, has, perhaps, a certain connection with the great fertility proved to exist in such marriages (WILHELMI, in Magdeburg, 6·0 in each, 108, p. 73; in Pommerania-Erfurt, 6·3, 134, p. 328; LEMCKE, in Mecklenburg, 6, 120, p. 99; and in the 28 Danish marriages, 6·9 in each), it being a well-known fact that infant mortality and fertility are closely related to each other.

(5.) Finally, the Irish statistics proved that the closer the degree of relationship between the parents the larger was the number of deaf-mute children born [149, p. 43]. This is confirmed by the results obtained from an investigation of the 47 marriages which resulted in the 52 Danish deaf-mutes mentioned in Table VIII.

1	marriage	between	aunt and nephew	produced	3	deaf-mutes.
4	marriages	,,	uncle and niece	,,	11	,,
26	,,	,,	first cousins	,,	38	,,
16	,,	,,	second cousins	,,	20	,,
47	marriages	between	blood relations	produced	72	deaf-mutes.

It will then be seen that there are various circumstances which clearly indicate that the intermarriage of relatives plays no insignificant part in the etiology of deaf-mutism. Everything, however, tends to prove that it is entirely, or principally, in *congenital* deafness that consanguinity is an important etiological factor.

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*It must be remembered that these investigations took place when the majority of the deaf-mutes were very young, which accounts for the comparatively larger number of children who were alive and normal.

It is, however, undecided whether consanguinity in itself is a remote cause of deaf-mutism, or whether it is through the intensified transmission of hereditary morbid conditions or tendencies prevalent in a family, that it makes itself felt. Theoretical considerations are strongly in favour of the latter supposition, but it is but fair to say that up to the present there have not been many or convincing facts brought forward in its support. Of these, the following are the most important.

Wilhelmi could only find hereditary influences in two of 18 consanguineous marriages with deaf-mute children [108, p. 72], and Mygge only in two out of 15 [131, p. 275], both authors merely having looked for deaf-mutism or partial deafness in the family. In Dr. W. Meyer's clinic, in Copenhagen, hereditary influence was found in five of 12 consanguineous marriages [189, p. 38], and in 13 of the 28 marriages of which the 33 congenital deaf-mutes mentioned in Table VIII. were born. The figures are only slightly increased (14) by including the nervous diseases mentioned on p. 68 and following. Finally, Lemcke found serious bodily and mental defects in 51 per cent. of his cases [210, p. 99], but he includes drink and tuberculosis, both of which are found in a very large number of families. The circumstance that, while 23 deaf and dumb children were born in the 14 consanguineous marriages in Denmark where no hereditary influence could be discovered, *i.e.*, on an average, 1·64 in each, the fact that 30 such children were born in the remaining 14 marriages of the same nature where hereditary influence could be proved to exist in one or more relatives, *i.e.*, on an average, 2·14 in each, throws a still stronger light on the importance of consanguinity. The results obtained in Dr. W. MEYER's clinic tend in the same direction [189, p. 38]. Should other statistics confirm the above, there will be reason to suppose that consanguineous marriages, contracted between members of a family with defects which are known to be of importance as remote causes of deaf-mutism, are more likely to produce deaf-mute children than others.

There are, then, but few facts which serve to elucidate the question whether the influence of consanguinity upon deaf-mutism is direct or indirect. Further investigations of the same nature will perhaps throw more light upon this subject. The final solution of the question will, however, in all probability, only be brought about by means of information as to family, supported by an exact knowledge of the relatives of the deaf-mutes, and supplemented by their thorough objective examination. It is only thus that it will be possible to find less pronounced, but not on that account less important, abnormalities in the family, and to discover with what frequency the influence of heredity can be with certainty excluded in consanguineous marriages producing deaf-mute children.

OTHER REMOTE CAUSES.—There are, besides the above-mentioned, several other remote causes which are, more or less properly, supposed to play a part in the etiology of deaf-mutism; of these the most important will be mentioned.

DISEASES IN THE PARENTS.—Numerous authors have considered, besides the diseases and abnormalities mentioned on p. 62 (ear-disease, insanity, epilepsy, &c.), general debility, alchoholism, syphilis, &c., in the parents, to be among the remote causes of deaf-mutism. HARTMANN has pointed out very justly that the importance of such diseases cannot be proved statistically, because the reports are often uncertain, and also because we have no statistics as to other large groups of individuals with which to draw comparison. There is, however, no doubt that all such diseases which weaken the parents' constitution, may affect the children, partly during fœtal life, and partly by rendering them more susceptible to external influences after birth. This is especially probable so far as alcoholism—which is common in families with "nervous" diseases—and syphilis are concerned, for which reason they will be considered more closely. On the other hand it must be observed that the parents of deaf-mutes are often apparently in possession of remarkably robust constitutions, a fact of which everyone who has the opportunity of examining them can easily convince themselves.

Alcoholism.—As the abuse of alcohol is particularly common it is necessary to prove its very considerable frequency among the parents of deaf-mutes before we can draw any conclusion as to the part it plays in the etiology of deaf-mutism. In Magdeburg, WILHELMI found only two cases of abuse of alcohol among parents [108, p. 68]. Of the parents of 382 deaf-mutes in the district of Cologne, LENT only found nine fathers who were "*dem Trunke ergeben*" [101,

p. 25]. In Mecklenburg-Schwerin, Lemcke found that in 405 marriages in which deaf-mute children were produced, 32 of the parents (in each case the male) were addicted to drink, *i.e.*, 8 per cent. of all the cases [210, p. 127], and with the same frequency among the parents of congenital deaf-mutes as in those of deaf-mutes with acquired deafness. This rate closely resembles that found for the 514 marriages in which the 553 Danish deaf-mutes were born, there being 49 cases, *i.e.*, 9·5 per cent., in which the parents were addicted to drink (in almost all instances the father). In Denmark, the frequency with which alcoholism was found varied slightly for the parents of congenital deaf-mutes and those with acquired deafness, the rates being respectively 11·1 and 8·7.

Although the abuse of alcohol is extremely common, and although we have no information as to its frequency on the whole, still the reports from Mecklenburg-Schwerin and Denmark seem to indicate that alcoholism in the parents plays some part in the etiology of deaf-mutism. It is at present impossible to form any accurate opinion as to whether alcoholism makes itself felt by weakening the parents' constitution or whether it is an expression of a nervous disposition. Theoretical considerations are most in favour of the latter supposition—it was, at least, not possible to prove, by investigations undertaken in a certain part of Denmark, any particular frequency of any abnormality in the children of parents addicted to the abuse of alcohol.

It may be mentioned in connection with the above that conception in an intoxicated state has been supposed to play some part among the remote causes of deaf-mutism. It is, of course, impossible to produce proofs for or against the correctness of this hypothesis.

Syphilis.—This disease has, on the whole, been found comparatively seldom among the parents of deaf-mutes. This does not, however, prove that syphilis plays no part in the etiology of deaf-mutism, for it is often difficult to find out by questioning whether an individual has, or has had, this disease, and it is also possible that investigations have, up to the present, been deficient in this particular. It is at all events certain that syphilis in the parents may produce a particular form of deafness in the children, appearing in the later years of childhood, and often leading to deaf-mutism. This form of deafness will be mentioned more particularly under the special etiology of acquired deaf-mutism.

AGE AND DIFFERENCE IN AGE OF PARENTS.—MENIÈRE was the first to draw attention to these two factors in the origin of deaf-mutism, stating that, according to his experience, deaf-mutes were often the children of young parents, and that such marriages were frequently sterile or resulted in weakly offspring [63, p. 225]. MENIÈRE declared also, that in the marriages in which deaf-mutes were born, the husband was either younger than the wife—owing to women of the labouring classes having amassed a small capital, which induced younger men to marry them—or both parties were of the same age, while the husband was seldom older than the wife. PUYBONNIEUX, whose work appeared the same year as MENIÈRE'S, was, however, of opinion that at least seven-tenths of the parents of deaf-mutes were over 30 at the time of the birth of the deaf-mute offspring, but he agreed with MENIÈRE in supposing that in such marriages—as in those between younger persons resulting in deaf-mute children—the wife was, as a rule, several years older than the husband [64, p. 21].

Later investigations have not confirmed the opinions of MENIÈRE and PUYBONNIEUX. It may be mentioned in particular that H. SCHMALTZ in Saxony, and LEMCKE in Meçklenburg-Schwerin, came to the conclusion that the age and the difference in the age of the parents of deaf-mutes were of no significance.

An examination into the ages of the parents of the 553 Danish deaf-mutes led to a similar result, and showed further that the average age of the parents at the birth of the deaf-mute did not differ greatly when the cases in question were divided into congenital and acquired cases, the difference in age of the parents being also about the same in both groups. The average age of mothers at the birth of congenital deaf-mutes was 33·9, and of the fathers 34·2; while the figures for the parents of deaf-mutes with acquired deafness were respectively 30·1 and 32·7.*

CIRCUMSTANCES RELATING TO OFFSPRING.—Various authors have proved that certain peculiarities connected with the offspring of marriages producing deaf-mutes must be considered as being among the remote causes of deaf-mutism. Of these the following are deserving of attention.

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* It may be remarked by way of comparison that RUBIN and WESTERGAARD found that the average age of Danish cottagers (to which class the majority of Danish deaf-mutes belong by birth) at marriage was for men 32·7, for women 30·6.

Great Number of Children.—All authors who have directed their attention to this subject agree that marriages producing deaf-mutes are remarkable for their fertility. Thus, WILHELMI found in Magdeburg that the average number of children born in each marriage producing congenital deaf-mutes was 5·09, and 5·63 in each marriage producing deaf-mutes with acquired deafness [108, p. 76 and 82]. The same author found in Pommerania and Erfurt 5·9 children in each marriage in the first mentioned group [134, p. 208]. From investigations in Mecklenburg-Schwerin LEMCKE found 5·63 children in each marriage producing deaf-mutes [210, p. 83]. The greatest fertility was reached in Saxony, viz., six children in each marriage in which deaf-mutes were born [H. SCHMALTZ, 161, p. 131]. Saxony is, however, according to H. SCHMALTZ, remarkable for the great number of children born in each marriage. The 514 marriages in which the 553 Danish deaf-mutes were born produced altogether 2,467 children, *i.e.*, on an average, 4·8 in each. In the 197 marriages producing congenital deaf-mutes 985 children were born, *i.e.*, 5·0 in each; in the 206 marriages producing deaf-mutes with acquired deafness 943 children were born, *i.e.*, 4·6 in each. Although this fertility is less than that found elsewhere—which is explained when we remember that the Danish deaf-mutes were generally younger at the time of the investigations than those included in other statistics—it is still high when compared with that of the population in general. MYGGE, namely, found in the rural districts of Denmark, on an average, only 3·65 children in each marriage [131, Table IV.]

None of the above-mentioned authors have given any explanation of the connection between deaf-mutism and the fertility of marriages producing deaf-mute children. It is not entirely impossible that this connection is partially indirect, being due to the circumstance that deaf-mutism is particularly frequent among the poorer classes of the population, which are also the most fertile. It is, however, remarkable that other pathological conditions, for instance, hemophilia, are found among the offspring of marriages producing a large number of children.

Infant Mortality.—It has already been stated (p. 33) that MAYR found a high deaf-mute rate in districts with a high rate of infant mortality. LEMCKE paid particular attention to this question in his examination of the deaf-mutes in Mecklenburg-Schwerin, and came to the following conclusions [210, p. 90]: While 192 per 1,000 children of the general population die in the first year of infancy, this is the case with 206 per 1,000 children born in marriages producing deaf-mutes. The same could not be proved for the children born in the marriages which produced the 553 Danish deaf-mutes. Should LEMCKE's results be confirmed by other statistics, there is a possibility that the explanation may be the same as that hinted at in regard to the fertility of the marriages producing deaf-mutes, and it is also deserving of mention that RUBIN and WESTERGAARD found that infant mortality in Denmark increased in direct proportion to the fertility of the marriages.

Time of Birth.—In Saxony, H. SCHMALTZ found that nearly half the deaf-mutes were born during the first five years of their parents' marriage [161, p. 133]; LEMCKE's investigations in Mecklenburg-Schwerin led him to the same result [210, p. 84], which was also confirmed by the Danish investigations, though not for congenital deaf-mutes, there being more of these who were born later. It is impossible to say what importance is to be attached to this circumstance so long as we have no information as to the population in general in this respect. Finally, H. SCHMALTZ is of opinion that a very large number of deaf-mutes are born, after a number of elder children, while the parents are of advanced age [161, p. 134], and he also lays great stress upon longer pauses in the series of births. LEMCKE considers that he has proved the latter hypothesis by his investigations in Mecklenburg-Schwerin.

Order of Births.—Since MENIÈRE first drew attention to this subject, several authors have published statistics referring to it, the result of all investigations published up to the present time being that deaf-mutes are most frequently first births. This was also the case with the 553 Danish deaf-mutes mentioned p. 45. According to some statisticians, second births take the next place, but according to others third births are more frequent. This circumstance is worthy of attention, as those statistics which have yielded the latter result are alike in this respect, viz., that they have entirely, or principally, embraced cases of congenital deaf-mutism. It was also found, on closer observation of the 553 Danish deaf-mutes, that, when considered together, a greater number were the result of second births, but that, when divided into congenital and acquired cases, there were a greater number of the former resulting from third than from second births, as will be seen from the following survey:

	Congenital.	Acquired.	Uncertain.	Total.
1st child . . .	50	57	23	130
2nd ,, . . .	34	42	26	102
3rd ,, . . .	37	27	15	79
4th ,, . . .	33	26	16	75
5th ,, . . .	21	16	9	46
6th ,, . . .	19	8	8	35
7th ,, . . .	13	9	9	31
8th ,, . . .	10	10	6	26
9th ,, . . .	0	1	2	3
10th ,, . . .	4	5	0	9
11th ,, . . .	3	2	0	5
Beyond ,, ,, or uncertain	2	5	5	12
	226	208	119	553

After these follow, according to all statistics, deaf-mutes resulting from fourth births, then fifth births, &c., &c.

Until we are in possession of information referring to other groups of individuals with which to make comparisons, it is impossible to draw any conclusion from hitherto published statistics as to the order of birth of the deaf-mute. For instance, we cannot prove, that because the majority of authors find about one-fourth of the deaf-mutes to be first births, first-born children are, therefore, more exposed to deaf-mutism, until we know what is the proportion of first-born in other large groups of individuals. It is, however, only reasonable to suppose from experience in daily life, that first-born children are really more exposed to deaf-mutism, as they are to so many other abnormalities and diseases. It is, meanwhile, worthy of observation that, according to the Irish census of 1881, deaf and dumb children were most frequently the last born in a family; this was, however, due to the circumstance that all deaf-mutes who were the only children in a marriage were included in this group [149, p. 43].*

Illegitimate Births.—Considering the important part which unfavourable social conditions play among the remote causes of deaf-mutism, it was naturally to be expected that a comparatively large number of deaf-mutes would be born out of wedlock, as illegitimate children seem to be especially exposed to the deteriorating influences of such conditions, which act either upon the mother during pregnancy, or upon the children themselves in early infancy. MATHIAS has also declared this to be the fact [70, p. 70], a statement which has not been confirmed by more recent investigations. Thus, according to H. SCHMALTZ, illegitimate births in Saxony represented about 12 per cent. of all births, while only 6·2 per cent. of the deaf-mutes in that country were born out of wedlock, and this author therefore justly concluded that illegitimate children were not more exposed to deaf-mutism than others [161, p. 64]. In Denmark there was a still smaller number of illegitimate unions producing deaf and dumb children, namely, only 27 of the 514 mentioned p. 45, *i.e.*, 5·4 per cent.* These figures differ but little from those of H. SCHMALTZ considering that illegitimate births in Denmark represent about 10 per cent. of the total number of births. In Magdeburg, WILHELMI found that only 2·2 per cent. of the unions producing deaf-mute offspring were illegitimate [108, p. 76], but gives no information as to the frequency of such births in that district. By way of comparison it may be observed that in Denmark 5·1 per cent. of the mothers of the congenital deaf-mutes included in the investigations were unmarried, while this was the case with 5·8 per cent. of the mothers of deaf-mutes with acquired deafness. Although it is possible that the comparatively small number of illegitimate deaf-mutes may, to a certain extent, be owing to the high infant mortality which prevails among children born out of wedlock, still, the difference between the rate of illegitimate births in unions producing deaf and dumb offspring and such births in general, is, according to hitherto published statistics, so considerable as to authorise the supposition that illegitimate children are less liable to deaf-mutism than others. The reason may perhaps be that illegitimate unions are seldom consanguineous. In the above-mentioned 27 cases in Denmark there was not one in which the parents were related.

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* According to this census also, families in which deaf mutes were born were most frequently families with five or six children, which was likewise the result arrived at by WILDE in 1851 [72, p. 471] This can be explained by the circumstance that the average number of children born in marriages producing deaf-mutes is 5-6 (*see* p. 98).

INFLUENCES DURING PREGNANCY.—Considering that mothers are much inclined to ascribe the bodily defects of their children to circumstances influencing themselves during pregnancy, it is remarkable that such influences are seldom mentioned among the causes of deaf-mutism. Thus, in 303 deaf-mutes, Lent found only 13 cases which were ascribed to maternal impressions [101, p. 14]. Wilhelmi found a comparatively still smaller number, viz., 15 out of 519 deaf-mutes; one of these he describes under the title *pium desiderium peculiare gravidæ.* It referred to a woman who, while pregnant, threatened her husband that she would give birth to a child who could neither hear nor speak; not only was the threat fulfilled, but she gave birth successively to four deaf-mute daughters, while three sons were normal [108, p. 70]. Finally, Lemcke mentions four deaf-mutes whose defect was ascribed by the parents to maternal impressions [210, p. 150]. For the sake of completeness I may mention that of the 553 cases in Denmark 11 were declared to be the result of fright, grief, or agitation, &c., during pregnancy. Further, one case of injury, one of scarlet fever, and two of typhus during pregnancy were mentioned as the causes of deaf-mutism. Three of the mothers had suffered from convulsions while pregnant. None of these were cases of acquired deaf-mutism.

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* This figure is identical with that calculated by J. CARLSEN in the case of illegitimate feeble-minded in Denmark, from which he draws the conclusion that feeble-mindedness is less common among illegitimate children, and supposes that is due to congenital feeble-mindedness [195, p. 42].

Although there can be no doubt that the connection between such maternal impressions and deaf-mutism is often purely accidental, it cannot, on the other hand, be denied that there is a possibility of powerful influences during pregnancy causing such considerable abnormalities in the auditory organs of the fœtus as to result in deaf-mutism.

INFLUENCES DURING DELIVERY.—Although it is difficult to prove the existence of such in individual cases, still there can hardly be a doubt that mechanical influences upon the child during delivery may result in deafness, which is congenital inasmuch as it is caused before delivery is completed.

Pressure upon the Head of the Fœtus.—It is to be supposed that mechanical pressure upon the head of the fœtus in delivery by forceps, version, and artificial delivery, also in difficult deliveries on account of narrowness of the pelvis, may injure the organs of hearing, and several authors have reported such cases. There were three among the 553 Danish deaf-mutes whose deafness might be considered to be due to such causes. As we, however, have no statistics relating to the frequency with which artificial deliveries take place, we have no standard by comparison with which to estimate the importance to be attached to the frequency with which such influences have played a part in the causation of deaf-mutism. The small number of cases would seem to indicate that they are but unimportant factors in the etiology of deaf-mutism.

Twisting of the Umbilical Cord.—Strange to say Moos found two out of 40 deaf-mutes the cause of whose deafness and co-existent deformity of the external ear was ascribed to the umbilical cord being twisted round the head at birth; in both cases the cord was said to have been twisted 13 times [146]. Moos subjected this supposed cause to an exhaustive criticism, and came to the conclusion that it was highly improbable that there was any connection between the twisting of the umbilical cord and the deformity of the external ear, neither is it probable that it was in any way connected with the deaf-mutism.

IMMEDIATE CAUSES.—Having described the more remote causes of deaf-mutism, we will proceed to consider the more immediate.

We are in possession of statistics from various places, which treat of the different ages at which deafness is most frequently acquired. HARTMANN'S statistics, for instance, include 649 deaf-mutes [132, p. 75], of whom the majority had become deaf in their second year, then followed those who had become deaf in their third year, then first, fourth, fifth, &c. According to this author in about two-thirds of the cases of acquired deaf-mutism the deafness is acquired during the first three years of infancy. Table IX. includes the principal statistics which have appeared upon this subject since HARTMANN'S work was published, and also the results yielded by the Danish investigations mentioned p. 45.

The results obtained from Table IX. differ somewhat from HARTMANN'S—the greater number of cases falling in the third year, then the second, the fourth, first, fifth, sixth, &c.; only one-half of the deaf-mutes having acquired deafness during the first three years of infancy. It will be seen, however, on closer observation, that it is the American statistics which, on account of their large figures, dominate the character of the total obtained, for, if only the European reports are considered, the results will coincide with HARTMANN'S. It must, however, be

TABLE IX.—RECENT STATISTICS AS TO THE APPEARANCE OF ACQUIRED DEAF-MUTISM AT DIFFERENT PERIODS OF AGE.

Year of Life.	Pommerania-Erfurt, 1874-75 [134, p. 307].	Saxony, 1880 [161, p. 153].	Würtemberg—Baden, 1880 [144, p. 119].	United States America, 1880 [180, p. 396].	Mecklenburg, 1885 [210, p. 140].	Denmark, 1879-90 (*see* p. 45).	Total.
1st . . .	185	139	47	1,009	38	34	1,452
2nd . . .	294	142	73	1,275	62	59	1,905
3rd . . .	236	137	38	2,447	53	50	2,961
4th . . .	126	80	47	1,569	36	23	1,881
5th . . .	105	50	11	989	24	9	1,188
6th . . .	61	41	16	806	11	10	945
7th . . .	45	37	0	540	18	6	646
8th . . .	22	20	0	392	8	5	447
9th . . .	15	13	0	304	6	1	339
10th . . .	14	7	2	193	4	6	226
11th . . .	5	1	0	261	2	2	271
12th . . .	6	4	0	72	0	1	83
13th . . .	3	2	0	198	2	0	205
14th . . .	2	0	0	69	1	0	72
15th . . .	2	0	0	94	0	0	96
Over 15th or uncertain	9	0	0	100	1	2	112
Total . .	1,130	673	234	10,318	266	208	12,829

observed that the reason why the first year of infancy only takes the third or fourth place among the ages at which acquired deafness most frequently appears, is probably that deaf-mutes who acquire deafness at that age, are often entered under the heading congenital deafness, or deafness of uncertain origin. The table proves, finally, that deafness acquired even after the age of puberty, may result in deaf-mutism, but as mentioned on p. 2, it is a matter of opinion whether such persons are to be considered as deaf-mutes.

BRAIN-DISEASES.—These play an important part in deafness acquired after birth and resulting in deaf-mutism. According to statistics collected by Hartmann (and including 832 cases of acquired deafness), 38·8 of these were the result of brain-disease [132, p. 76]. Since this work was published, in 1880, several others have appeared from various countries, showing the frequency with which brain-diseases (including "convulsions," "water on the brain," "inflammation of the brain," &c.) had caused deafness in the cases of acquired deaf-mutism furnishing material for the various investigations. The Irish statistics of 1881 show the lowest figure, viz., 11·9 per cent. [149, p. 295]; Saxony follows with 16·0 [161, p. 150]; Italy with 18·1 [176, p. 18]; Austria with 25·8 [176, p. 21]; Norway with 32 [203, p. 100]; America with 33.9 [179, p. 403]; Mecklenburg-Schwerin with 38·7 [210, p. 141]; Baden and Wurtemberg with 42·3 [144, p. 118]; and Pommerania-Erfurt with 54·5 per cent. [134, p. 301]. To this may be added that 83 of the 208 Danish deaf-mutes with acquired deafness were stated to have become deaf after brain-diseases, *i.e.*, 39·9 per cent.

That the importance of brain-diseases in the etiology of deaf-mutism varies so considerably in the different countries, is not only due to the circumstance that the expression "brain-disease" includes different affections in the different reports, but also to the varying intensity with which cerebral disease appears at different times and in different places. Thus Wilde states, that in 1851 the same diseases as mentioned in the census of 1881 ("brain convulsions," "inflammation of the brain," "water on the brain," &c.) caused 23·0 per cent. of the cases of deaf-mutism, while this was, as mentioned above, the case with only 11·9 per cent. in 1881. Earlier investigations made in Saxon, Norwegian, and Danish Deaf and Dumb Institutions give different results to those stated above. This is doubtless owing to the circumstance that cerebro-spinal meningitis, which is the most important cause of deaf-mutism, appears with very varying intensity and character at different periods.

All modern investigators, however, agree, that brain-diseases are at present the predominant cause of acquired deaf-mutism.

The importance which thus attaches to brain-diseases in the etiology of deaf-mutism can hardly be diminished by the circumstance that various other diseases with marked brain symptoms are classified under the same heading, for there is no doubt that acute brain-diseases, and especially cerebro-spinal meningitis, which often appears with symptoms resembling those of typhus, or pneumonia, are frequently reported under typhus, inflammation of the lungs, or uncertain diseases.

Statistics are often very deficient in information as to which form of cerebral disease most frequently causes deaf-mutism, expressions such as "convulsions," "teething convulsions," "water on the brain," "epilepsy," "fits," &c., often being made use of. This is owing to the information being given by other than medical men, and also to the difficulty with which a correct diagnosis can be formed of acute brain-disease in children. It seems, however, that simple inflammation of the brain and epidemic cerebro-spinal meningitis are the principal factors in deaf-mutism.

Simple Inflammation of the Brain. (Meningitis simplex).—In Magdeburg this disease is stated to be the most frequent cause of acquired deaf-mutism [108, p. 77], 28·0 per cent. of the deaf-mutes in that district owing their deafness to it. Mecklenburg-Schwerin follows with 23·3 [210, p. 141], and Norway with 20 per cent. [203, p. 100]. In Denmark 20 of the 208 cases of acquired deaf-mutism were owing to "inflammation of the brain," 9·6 per cent.

Epidemic Cerebro-Spinal Meningitis. (Meningitis cerebro-spinalis epidemica).—This peculiar disease appeared first in Switzerland in the beginning of this century, from thence it spread over the greater part of Europe and reached America, appearing with greatest virulence in Europe about 1855-6. Previously to that time it is not mentioned as a cause of deaf-mutism, but it has since come more and more to the front. The deleterious influence of this disease upon the infantile organs of hearing was especially pointed out by Moos [Klinik der Ohrenheilkunde, p. 323] and Knapp [110], whilst its great importance in the etiology of deaf-mutism was plainly proved by Wilhelmi's investigations in Pommerania-Erfurt, published by Hartmann [134], according to which not less than 26·8 per cent. of the deaf-mutes in that province in 1874-5 owed their deafness to this epidemic disease. Wilhelmi is also of opinion that the number of cases of deaf-mutism caused by this disease is in reality much greater, as many were doubtless included under the headings "inflammation of the brain" and "typhus." Other important statistics give a much smaller ratio of cases of acquired deaf-mutism caused by epidemic cerebro-spinal meningitis. Thus Uchermann places the ratio in Norwegian Deaf and Dumb Institutions at 23·5 [168, p. 74], but for Norway in general at 12·0 [203, p. 100]. For the Deaf and Dumb Institutions of Baden Hedinger gives it as 14·0 [144, p. 118], Lemcke 1·5 for Mecklenburg-Schwerin [210, p. 141], and H. Schmaltz only 1·1 per cent. in Saxony [161, p. 149].

In Denmark, epidemic cerebro-spinal meningitis has not been generally recognised as an important cause of deaf-mutism, and it is only reported four times as causing deafness in the 208 cases of acquired deaf-mutism mentioned on p. 45. Although this may be partly owing to the circumstance that this disease has never appeared in Denmark in such violent and wide-spread epidemics as in other countries, still there is much which seems to indicate that it has played a much more important part than is generally supposed [200, p. 388 and following].

The Origin of Deafness in Brain-Diseases.—We possess various clinical observations of partial or complete deafness caused by epidemic cerebro-spinal meningitis, and post-mortem examinations of individuals whose deafness was due to this disease, or to other similar brain-diseases, which elucidate the manner in which cerebral affections act deleteriously upon the infantile organs of hearing. The great conformity which exists between the changes in the auditory organs caused by cerebro-spinal meningitis and changes declared to be due to inflammation of the brain in general, or to other diseases with pronounced cerebral symptoms, authorises us to suppose that the facts related in the following paragraphs hold good for the majority of cases of deaf-mutism caused by acute brain-diseases.

Clinical experience teaches us that the very considerable defects in hearing which appear during epidemic cerebro-spinal meningitis may have a dual origin, viz., inflammation of the middle ear, or an affection of the labyrinth. Loss of hearing from the former cause is, however, seldom so considerable or so lasting as to result in deaf-mutism. Deafness resulting from labyrinthine disease is more rare, but, at the same time, of more importance, since the loss of hearing is as a rule very considerable, often indeed total, generally affecting both sides, and nearly always permanent. According to Moos [139, p. 12 and following] and Knapp [110], labyrinthine deafness in epidemic cerebro-spinal meningitis generally appears suddenly, seldom gradually. As a rule it appears in the course of the first two weeks, but may also show itself later; Knapp reports a case where it appeared even six months after the commencement of the disease. The following case, observed by me, seems to prove that deafness may appear even at a longer time after the inflammation of the brain has been cured.

Case No. 24. Anders, S., is the son of healthy parents, who are related to each other (second cousins), but among whose relations there are no cases of deaf-mutism, deafness, insanity, &c. He was born February 26th, 1887. When three months old the child had convulsions, screamed violently, lay with his head thrown back and abdomen contracted, and was declared by the medical attendant to be suffering from inflammation of the brain. He was seriously ill for 12 weeks, but recovered completely, and has not been ill since. He began to walk when two years old, the gait being for a considerable time staggering and uncertain. In September, 1888, about a year after his recovery from inflammation of the brain, the child suddenly left off speaking without any illness showing itself. Since then he has forgotten all the words he had learned, and has exhibited no signs of hearing. On the 10th of October, 1890, I examined the child, and found total deafness on both sides. A large quantity of adenoid vegetations were removed under chloroform, and air was injected into both tubæ, which, like the drumhead, exhibited no remarkable anomaly. The hearing was and remains entirely absent.

Hitherto-published post-mortem examinations of individuals who have become deaf after epidemic cerebro-spinal meningitis give the results stated below. These examinations have been exhaustively discussed by Moos [139, p. 16 and following], to whose list may be added an interesting case examined by P. C. Larsen [185], and some reports of dissections* of deaf-mutes whose deafness was due to inflammation of the brain or epidemic cerebro-spinal meningitis, Mackeprang and Ibsen [216, spec. No. 48 and 49], H. Schwartze [102], Moos and Steinbrügge [159], W. Schultze [186], Larsen and Mygind [188], and Habermann [205]. Deafness appearing during cerebro-spinal meningitis, and resulting in deaf-mutism, is, as a rule, due to an inflammatory process of the membranous labyrinth. This process leads partly to the more or less complete destruction of the contents of the labyrinth, and partly to the regeneration of tissue. This new tissue may be either fibrous, calcareous, or osseous, and may fill the normal cavity of the labyrinth either completely or partially. It is possible that cerebral inflammation and labyrinthine affection may appear simultaneously as the result of the same infection, but the circumstance that the deafness generally appears some time after the beginning of the disease, indicates that the ear-disease is, as a rule, a result of the propagation of the inflammation from the membranes of the brain. The inflammation seems to be propagated through the perivascular and perineural lymphatic spaces, and also by the aqueducts of the ear. The former is especially pointed out by Moos [139, p. 20]. In favour of the latter mode of propagation are the circumstances that Habermann found the aqueductus cochleæ filled with the same granulation tissue as the cochlea itself [Zeitschrift für Heilkunde, Bd. V., p. 34]; that Steinbrügge was able to demonstrate that pus penetrated from the cerebral cavity to the cochlea through the aqueducts [171, p. 284]; and that Larsen and Mygind found both aqueducts closed by the same osseous mass as filled the labyrinth [188, p. 190]. It is worthy of mention that Lucæ found the inflammation propagated along a continuation of dura mater penetrating into the petrous bone [147, p. 556]. It is highly probable that the original cause of disease is an immigration of micro-organisms, but it is at present impossible to express a decided opinion upon this matter [Moos, 217, vol. i., p. 575].

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* The majority of the reports of post-mortem examinations mentioned here and in the following pages have been published collectively in the "Archiv für Ohrenheilkunde," to which readers are referred [Mygind, 187].

Deafness caused by brain-disease is often accompanied by disturbances of equilibrium, which has been especially mentioned by Moos [139, p. 11 and following]; these disturbances are doubtless due to the inflammatory process in the labyrinth, and especially in the semicircular canals. These disturbances of equilibrium may last for years after the appearance of deafness in the form of staggering gait (*see* below).

ACUTE INFECTIOUS DISEASES.—The importance of this group of diseases in the etiology of deaf-mutism is doubtless at present less marked than that of brain-diseases. If, however, epidemic cerebro-spinal meningitis is included amongst acute infectious diseases—to which group it doubtless belongs—they immediately assume a very prominent place, and there can be no hesitation in declaring that the great majority of cases of deaf-mutism caused by acquired deafness are the result of acute infectious diseases. The importance of the parts played by different diseases varies greatly, as will be seen from what follows, scarlet fever predominating.

Scarlet Fever (Scarlatina).—This disease has always, and in all countries, been recognised as a very frequent cause of infantile deafness, and, consequently, of deaf-mutism. Strange to say, ITARD paid but little attention to it, while WILDE laid great stress upon it, finding that 7·0 per cent. of the cases of acquired deaf-mutism in Ireland in 1851 were owing to it. WILDE relates further, that the Deaf and Dumb Institution in New York had collected statistics according to which 5·6 per cent. of the cases of acquired deaf-mutism were caused by scarlet fever, whilst SAUVEUR, from other statistics, found 11·3 per cent. [72, p. 485 and following]. Since then, Hartmann found, on comparing returns from various parts of Germany, that 11·3 per cent. of the cases of acquired deaf-mutism were due to this disease [132, p. 76]. Later statistics differ considerably on this point, as will be seen by the following figures, which represent the ratio of deaf-mutes with deafness caused by scarlet fever: Italian Deaf and Dumb Institutions, 1·5 [176, p. 18]; Pommerania-Erfurt, 9·9 [134, p. 307]; Austrian Institutions, 10·8 [176, p. 21]; Institutions in Würtemberg and Baden, 15·0 [144, p. 118]; Ireland, 16·8 [149, p. 295]; North American Institutions, 16·9 [179, p. 418]; Mecklenburg-Schwerin, 24·4 [210, p. 141]; United States of North America, 26·4 [179, p. 412]; Norwegian Institutions and Norway, 27·5 [168, p. 74, and 203, p. 100]; and Saxony, 42·6 [161, p. 150].

Of the 208 Danish deaf-mutes with acquired deaf-mutism, 43, *i.e.*, 20·8 per cent., owed their deafness to scarlet fever. In the Royal Deaf and Dumb Institution in Copenhagen, Salomonsen had, at an earlier date, found a still higher rate, viz., 33·4 [173, p. 45].

It is thus evident that the influence of scarlet fever upon deaf-mutism differs in different countries and at different times, which is doubtless due to the varying intensity and character with which this disease appears.

The Origin of Deafness in Scarlet Fever has been elucidated by clinical research, which proves that ear-diseases caused by scarlet fever generally consist of inflammation of the middle ear, with a marked tendency to destroy the mucous membrane and osseous walls of the tympanum, and also the auditory ossicles. The inflammations of the middle ear, which accompany scarlet fever, and which are most frequently propagated through the Eustachian tubes, but which may perhaps appear independently, are not in themselves capable of causing a diminution of hearing in infancy so lasting and so considerable as to result in deaf-mutism unless the labyrinth is also affected. Scarlatinal deafness resulting in deaf-mutism is then doubtless due to a partial or entire destruction of the membranous contents of the labyrinth. This destruction is in many cases caused by the propagation of the inflammation to the internal ear either through the fenestræ *(fenestra rotunda et ovalis)* or through the vessels leading from the tympanum to the labyrinth. Some post-mortem examinations of deaf-mutes, whose deafness was the result of scarlet fever, support the former theory, indications of an inflammation of the middle ear being found, also abnormalities in one or both fenestra, doubtless the result of an inflammatory process [Moos, 215; Uchermann, 207; Bryant and Sears, 208; Mygind, 214]. On the other hand there are various circumstances which indicate that scarlatinal affections of the labyrinth may appear independently of an inflammation of the middle ear, or that, if such inflammation has existed, it has been very slight. Thus, for instance, it is often found, on otoscopic examination of deaf-mutes who have become deaf after scarlet fever, that the drumhead exhibits but slight or no abnormalities. Hartmann draws particular attention to this circumstance, and he found that in the majority of cases of deaf-mutism caused by scarlet fever (and typhus) the drumhead was normal [132, p. 79], and H. Schmaltz came to a similar result [161, p. 162]. It seems then that infantile scarlatinal affections of the labyrinth may make their appearance independently of any inflammation of the middle ear, that is, as a "metastasis," in the same way as scarlatinal kidney affections. Future post-mortem examinations of cases where the labyrinthine disease has been of recent date will doubtless set this question at rest.

We possess numerous more recent investigations as to the nature of the inflammatory process which causes an affection of the ear in scarlet fever. According to Moos, who has gone very minutely into this question, and has published much valuable information upon it, the scarlatinal inflammation of the ear is due to scarlatinal throat diphtheria, which forms the starting point for an invasion of *streptococcus pyogenes*, the attacks of which on the ear result partly in necrobiotic, partly in inflammatory, processes. The investigators above mentioned have found the remains of this latter process in deaf-mutes with scarlatinal deafness, in the form of the same new formations of fibrous tissue, calcareous tissue, and osseous tissue, as was described under brain-disease, which formations may fill up the cavity of the internal ear more or less completely.

It is seldom that scarlatinal deafness resulting in deaf-mutism appears at an early stage of the disease; at least BURCKHARDT-MERIAN declares that in the cases of ear-affection accompanying scarlet fever observed by him, the majority showed themselves at the period of desquamation [133, p. 9]. Deafness of this nature may also be accompanied by disturbances of equilibrium (*see* p. 114.)

Measles (morbilli).—Itard believes measles to be a frequent cause of infantile deafness [31, vol. ii., p. 380], in which opinion he is supported by Meissner [76, p. 158]. Wilde, however, found that only 1·4 per cent. of the Irish deaf-mutes in 1851 were deaf after this disease [72, p. 486]. According to Hartmann's review [132, p. 76] on an average 3·6 per cent of the cases of acquired deafness were due to measles, the ratio, however, varying from 0·0 (Meersburg and Gerlachsheim) to 8·0 (Berlin). Later statistics embracing large groups of deaf-mutes give the following results: Institutions in Würtemberg and Baden 1·0, Italian Institutions 1·2, Austrian Institutions 2·0, Norway 2·5, Norwegian Institutions 3·4, Ireland 3·8, North American Institutions 4·0, Magdeburg 4·3, the United States of North America 4·4, Pommerania-Erfurt 4·4, Saxony 7·0, and Mecklenburg-Schwerin 8·3 (for literature, *see* p. 116). Eleven of the 208 Danish deaf-mutes with acquired deafness owed their abnormality to measles, *i.e.*, 5·3 per cent. It will thus be seen that the reports relating to the frequency of measles as a cause of deaf-mutism vary greatly, though not so much as was the case with scarlet fever, which disease also assumes a much more prominent rank in the etiology of deaf-mutism. It will be seen further that measles do not always play an equally important part in the causation of deaf-mutism even in the same country, which is doubtless explained by the varying intensity and character with which epidemics of this disease appear.

The Origin of Deafness in Measles.—Clinical researches prove that measles often causes inflammation of the middle ear by a propagation of inflammation from the naso-pharynx through the Eustachian tube. Inflammation of the middle ear during measles may also appear "hæmatogenically" [Moos, 217, vol. i., p. 567]. This latter mode is especially probable in cases where the inflammation of the middle ear appears at a particularly early, or particularly late stage of the disease. It is not, however, probable that an inflammation confined to the middle ear is capable of producing deaf-mutism, the cause of which is doubtless always labyrinthine affection. A post-mortem examination of a boy of three years old, whose labyrinth was examined by Moos at an early stage [179], elucidates the origin and nature of these affections. In this case an inflammation was found in the internal ear, which process had been propagated from the middle ear through an opening in the *membrana tympanica secundaria*, accompanied by an invasion of bacteria and producing a degeneration of the membranous labyrinth, and in some places the destroyed tissue was already replaced by new osseous formations. The further progress of such formations is plainly shown by the dissection of a male deaf-mute aged 27, whose deafness was the result of measles in childhood [Mygind, 198]. In this case the normal cavity of the labyrinth was found to be partially filled by solid osseous masses which also occupied the *fenestra rotunda*, the tympanic cavity exhibiting evident traces of inflammation. There are also four specimens in the Pathological Museum of the Copenhagen University of the auditory organs of deaf-mutes whose deafness was caused by measles [216, spec. No. 32–33 and 44–45], in both of which the labyrinthine cavity was found to be partially filled by an osseous mass. Deaf-mutism caused by measles bears thus, so far as its origin and morbid anatomy is concerned, a great resemblance to that caused by scarlet fever. There is also reason to suppose that cases of labyrinthine affection during measles may appear independently of inflammation of the drum. The circumstance that deaf-mutes whose deafness is caused by measles often exhibit a normal drumhead, speaks strongly in favour of this hypothesis [H. SCHMALTZ, 161, p. 162].

Typhus (febris typhoidea s. typhus abdominalis s. ileo-typhus, typhus exanthematicus, typhus recurrens s. febris recurrens).—In deaf-mute statistics typhus doubtless includes not only the diseases in parenthesis but also numerous other diseases with typhoid symptoms. Earlier reports as to the frequency with which typhus caused deaf-mutism will be omitted, as this term was then differently understood. According to HARTMANN, not less than about 20 per cent. of the cases of acquired deaf-mutism were due to this disease. The majority of more recent investigations give a much lower ratio. Typhus is, however, reported as being the cause of deafness in 47·5 per cent. of the cases of acquired deaf-mutism in the Italian Deaf and Dumb Institutions. Ireland follows with 13·5 per cent. due to "fever," Pommerania-Erfurt with 12·5 due to "typhus," Austrian Institutions with 8·6, Saxony with 6·7, the United States of North America with 5·6, the Institutions of this country with 5·2 (both, however, including malaria), Norway with 4·4 ("nerve-fever"), Mecklenburg-Schwerin with 3·4, Norwegian

Institutions with 2·5 ("nerve-fever"), and Baden with 2·0 ("nervous diseases" included). Of the 208 Danish deaf-mutes, two were reported to be deaf from typhus, *i.e.*, 0·9 per cent. The frequency of typhus then as a cause of deaf-mutism varies greatly in different places. With the exception of Italy, where typhus seems to have played an important part in recent years, it appears in most places to be one of the minor factors in the etiology of deaf-mutism. It will also be seen that most statistics include other diseases under the heading typhus. It is probable that the varying frequency with which typhus causes deaf-mutism is not only due to the varying intensity of epidemics, but also—and perhaps chiefly—to the circumstance that other diseases with typhoid symptoms are included under the term typhus. Epidemic cerebro-spinal meningitis in particular may assume a distinctly typhoid character. As this disease is a frequent cause of deaf-mutism, and as typhus comparatively seldom attacks children, and infants enjoy immunity from this disease, and as it has no very great tendency to cause any serious destruction of the labyrinth, there is reason to suppose that cases of cerebro-spinal meningitis are often concealed under the term typhus.—We possess but few clinical observations which elucidate the origin of deafness in cases of deaf-mutism caused by typhus, but it is probably the same as that described for other infectious diseases.

Diphtheria.—The relationship of this infectious disease to deaf-mutism is in many ways opposite to that of typhus, for although diphtheria of the throat, according to Moos, frequently leads to serious affections of the middle and inner ear, and although it is a disease which most frequently attacks children, still it is seldom reported as a cause of deaf-mutism. The American statistics of 1880 are especially deserving of notice among those which mention diphtheria as a cause of deaf-mutism. Here there were only 70 out of 10,000 cases of acquired deaf-mutism in which the cause of deafness was given as diphtheria, *i.e.*, 0·7 per cent. In Saxony the rate was still smaller, viz., 0·3 per cent., whilst LEMCKE found that 1·5 per cent. of all cases of acquired deaf-mutism were due to this disease. The rate in Italy is comparatively high, viz., 5·3. Five of the Danish deaf-mutes reported between 1879–90, *i.e.*, 2·4 per cent., were deaf from the results of diphtheria. Although it is not impossible that cases of so-called scarlatinal throat-diphtheria are sometimes reported as diphtheria, owing to only a slight appearance or entire absence of the exanthem, still Moos' investigations seem to prove that diphtheria is a factor of some importance in the etiology of deaf-mutism, which abnormality is in such cases caused by labyrinthine affection resulting from invasions of micro-organisms. As the local symptoms are often but little pronounced in cases of throat-diphtheria, there is reason to suppose that the primary affection is often overlooked, and the origin of the case therefore mistaken.

Smallpox (variolæ).—As early as 1821 ITARD declared "that smallpox is, or rather has been, a frequent cause of deaf-mutism" [31, p. 381]. In 1848 E. SCHMALZ was of opinion that smallpox was a frequent cause of deaf-mutism [70, p. 18], and he states that not less than 22·2 per cent. of the deaf-mutes in the Deaf and Dumb Institution in Leipsic, in the years 1818–38, owed their deafness to this disease. In 1880, however, H. SCHMALTZ could only find in Saxony 2·8 per cent. of the cases of acquired deaf-mutism resulting from smallpox [161, p. 150]. In 1851 WILDE found smallpox to be the cause of 2·4 per cent. of the cases of acquired deaf-mutism [72, p. 486], the corresponding number in 1881 being only 1·4 [149, p. 295]. More recent investigations have given the following results: In the Austrian Deaf and Dumb Institutions, in 1884, 2·4 per cent. of the cases of acquired deaf-mutism were the result of smallpox; in Pommerania-Erfurt, from 1874–5, 1·0; in the Italian Institutions, in 1887, 0·8; in the United States of North America, in 1880, 0·5; in Mecklenburg-Schwerin, in 1885, 0·4; in the American Institutions, in 1880, 0·3; and in the Institutions in Würtemberg-Baden, in 1882, 0·0 per cent. Of the 208 cases of acquired deaf-mutism in Denmark two were the result of smallpox. It is thus evident that smallpox, which was formerly an important cause of deaf-mutism, now plays an inferior part in the causation of that abnormality in all countries from which we possess statistics upon this subject, the reason being that vaccination is now compulsory in all these countries. It will also be seen that the frequency with which smallpox causes deaf-mutism has been much more constant in later times.

Vaccination.—There are mentioned in the American statistics among "causes which have been rejected as too vague, improbable, or inconsequent, to be included in a formal tabulation," six cases (in 10,000 cases of acquired deaf-mutism) which are said to have been caused by vaccination [179, p. 416]. Among the 208 Danish cases of acquired deaf-mutism there was one in which the child's mother declared that it had become deaf, when 1½ years old, from the effects of vaccination. It cannot be denied that vaccination may possibly cause deaf-mutism, but no well-substantiated cases prove that it is so.

Chickenpox (varicellæ).—In 1880 this infectious disease was stated to have caused ten of 10,000 cases of acquired deaf-mutism in the United States of North America [179, p. 402].

Erysipelas.—In Saxony H. Schmaltz found that 0·1 per cent. of the cases of acquired deaf-mutism were due to erysipelas [161, p. 149]. In America the rate in 1880 was 0·4. In Ireland in 1880, 0·1. In Denmark one of the 208 cases of acquired deaf-mutism was reported as caused by this disease.

Dysentery (dysenteria).—According to Wilde, 0·6 per cent. of the cases of acquired deaf-mutism in Ireland in 1851 were due to dysentery. In America the rate was 0·06 per cent.

Influenza (influenza epidemica).—Considering that this disease often affects the ear very considerably, it is surprising that Wilde is the only author who mentions it as a cause of deaf-mutism in 0·6 per cent. of the cases of acquired deaf-mutism in Ireland in 1851.

Ague (malaria s. febris intermittens).—Statistics from the Italian Deaf and Dumb Institutions, in 1887, declare malaria to have been the cause of deaf-mutism in 1·3 per cent. of all the cases. According to Wilhelmi this disease gave rise to deaf-mutism in one of 230 cases of deaf-mutism in Magdeburg. Malaria is included under typhus in the American statistics of 1880.

Whooping-cough (tussis convulsiva s. pertussis).—Some authors make no mention of whooping-cough, whilst others are of opinion that it occasionally gives rise to deaf-mutism. It is thus reported as a cause of deaf-mutism in Ireland in 1881 in 0·4, and in 1885 in 1·0, in Mecklenburg-Schwerin in 1·5, in Saxony in 1·5, and in America in 1·9 per cent. of all cases of acquired deaf-mutism. Not less than nine of the 208 Danish deaf-mutes with acquired deafness owed their abnormality to this disease, *i.e.*, 4·3 per cent. Wilde remarks that he cannot determine whether whooping-cough produces deafness by local injury to the ear caused by a violent fit of coughing, or from its effect on the nervous system. It is possible that as paroxysms of coughing may produce bleeding of the ear, hæmorrhage of the labyrinth may be caused in the same manner, but it must be remembered that whooping-cough is such a common and protracted infantile disease that it is necessarily often complicated with other diseases, the symptoms of which latter are lost sight of in severe cases of the former.

Mumps (parotitis epidemica).—This infectious disease is only reported to be a cause of deaf-mutism in statistics from Saxony with 0·3 per cent., and America with 0·5 per cent. It is remarkable that mumps is so seldom reported as causing deaf-mutism, since there are numerous cases related in modern literature in which labyrinthine disease resulted from this disease, many of which cases concern children of such an early age as to render a consequent deaf-mutism highly probable. For instance, L. Connor collected all the cases of sudden deafness caused by mumps, which had been published up to 1884, and found that nine of the 33 individuals in question were 15 years of age or less (American Journal of Medical Sciences, October, 1884).

Inflammation of the Lungs (pneumonia crouposa).—Although it is doubtful how far this disease belongs to acute infectious diseases, it is included here from practical considerations. Inflammation of the lungs is stated by Uchermann to be the cause of deaf-mutism in Norway in 0·5 of all the cases, and in Denmark it was stated as giving rise to deaf-mutism in two of the 208 cases of acquired deafness. As epidemic cerebro-spinal meningitis may assume the character of pneumonia, it is possible that it is that disease which has been diagnosed as inflammation of the lungs in the above-mentioned cases; but it is, on the other hand, probable that inflammation of the lungs may occasionally result in deaf-mutism.

Rheumatic Fever (febris rheumatica).—The same remarks hold good for this disease as for the above. In the American statistics of 1880, it is said to have caused deaf-mutism in 0·05 per cent. of all cases of acquired deaf-mutism [179, p. 417]. In Magdeburg, Wilhelmi gives the rate as 0·4 per cent. [108, p. 77].

CONSTITUTIONAL DISEASES.—Of these, rickets, scrofula, and syphilis are particularly worthy of notice.

Rickets (rachitis).—As this constitutional disease has been proved to be of some importance as a direct or predisposing cause of ear-disease [Moos, 217, vol. i., p. 542], it is probable that it may also lead to deaf-mutism, as reported by Lemcke from Mecklenburg-Schwerin, where scrofula and rickets caused 5·3 per cent. of all cases, and by Uchermann from Norway (1·4 per cent.), and in the American statistics of 1880 (0·05 per cent.).

Scrofula (scrophulosis).—This constitutional disease is stated to have caused acquired deaf-mutism with the following frequency: Ireland 1881, 0·1 per cent.; Magdeburg 1874–75, 0·5 per cent.; America 1880, 1·3 per cent.; and Denmark 1879–90, 1·0 per cent. (two cases). It probably causes deaf-mutism by predisposing to suppuration of the middle ear.

Syphilis.—Although this constitutional disease is represented in most statistics relating to the causes of deaf-mutism by only a fraction or not at all, there can be no doubt that when inherited from the parents it plays some part in deafness acquired in infancy and resulting in deaf-mutism. Inherited syphilis may, as it is well known, produce a peculiar form of deafness accompanied by certain ocular affections, which, it is true, generally appears after the age of puberty, but which, however, also shows itself before that period, even as early as the age of four [Mygind, 184, p. 5]. The circumstance, however, that hereditary syphilitic deafness often appears without any other marked symptoms of syphilis, and that it is extremely difficult to discover syphilis in the parents, expecially by means of questions alone, explain why this disease is so seldom notified in parents in hitherto published statistics. It seems also probable that acquired syphilis may cause deaf-mutism, but no investigators have up to the present touched upon this subject.

PRIMARY EAR-DISEASE.—Almost all statistics contain a column for "ear-diseases," "otitis," "inflammation of the ear," &c., among the causes of deaf-mutism, and from 0·4 (Ireland, 1881) to 31·6 per cent. (Würtemberg, 1880) of deaf-mutes with acquired deaf-mutism are entered under it. As nearly all cases of acquired deafness resulting in deaf-mutism are doubtless caused by ear-disease, the above-mentioned classification does not seem quite logical. It is, however, probable that *primary* ear-disease is meant in all these cases, that is, ear-disease which appears independently of general malaise (for instance, acute infectious diseases), or local influences (lesions, &c.), or propagation from the brain (brain-disease). Ear-diseases propagated from the naso-pharynx ought, however, to be included under primary ear-diseases. It must, however, be remembered that such ear-diseases, if confined to the middle ear, seldom cause so considerable a destruction of the auditory organ as to produce deafness resulting in deaf-mutism, and further, that primary bilateral labyrinthine affections—of which the so-called *otitis intima of Voltolini* is the chief—are very rare in childhood, if indeed they exist at all. The high percentage which is reported from various places must then be looked upon with some mistrust, the more so from the fact that many of the reports as to the causes of deaf-mutism are filled in by laymen, who may easily overlook the principal cause when that is a slight, or abortive form of one of the brain or acute infectious diseases which are, as is well known, often accompanied by serious ear-troubles when they occur in infancy. There is, on the other hand, no doubt that primary inflammations of the middle ear may, especially by attacking the labyrinth, give rise to such early and severe deafness as to result in deaf-mutism. It is difficult to say what part these ear-diseases play in the etiology of deaf-mutism, as it must be often almost impossible for even the most experienced otologist to decide with certainty whether an infantile inflammation of the middle ear, accompanied by a labyrinthine affection, is primary or not, even when such inflammations come under observation at a very early stage.

OTHER INFLUENCES.—Besides the above-mentioned causes of deaf-mutism, the different statistics include numerous others, some of undoubted importance, others problematical, and others, again, extremely improbable. Among the latter may be mentioned "*worms*," "*teething*," "*teething convulsions*," "*diarrhœa*," *&c*. Among the doubtful are "*burns*," "*bronchial catarrh*," "*chloroform anæsthesia*," "*improper medical treatment*,"* *&c*. To the first group belong *fright* [UCHERMANN, 194], *struck by lightning* [WILHELMI-HARTMANN, 134, p. 211],

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* There are numerous cases in the American statistics in which the medical man is accused of causing deaf-mutism in the case in question.

sun-stroke (31 cases of which were reported from America in 1880), *quinine poisoning* (78 cases also from America), *colds* (which LEMCKE gives as cause of deaf-mutism in not less than 1·1 per cent. of the cases in Mecklenburg-Schwerin), *sudden immersion in water* (WILDE, 1·3 per cent.) and *lesion* or *injury*.

Injury (trauma).—Although it is probable that traumatic influences, such as falls, blows on the head, &c., to which children are especially subject, are sometimes stated as being the cause of deaf-mutism in cases of really congenital origin, there is no doubt that such causes may produce deafness resulting in mutism, as ear-diseases of traumatic origin are not at all unknown even among adults. Injury is included in the causes of deaf-mutism in nearly all the more considerable statistics. Thus LEMCKE reports not less than 5·0 per cent. of the cases of acquired deaf-mutism in Mecklenburg-Schwerin as being of traumatic origin, and "falls," "blows," and "contusions," in the American statistics of 1880 represent 4·3 per cent. The 208 Danish deaf-mutes with acquired deafness exhibit the lowest percentage of cases caused by injury, viz., 1·4 per cent.

COMBINED CAUSES.—It seems but natural to suppose that deaf-mutism may be due to two or more different but simultaneous or successive causes. There is, however, no information upon this subject in literature, for which reason a few cases noticed in Denmark will be mentioned shortly. In two cases the cause of deaf-mutism was said to be inflammation of the brain during whooping-cough. It is difficult to decide whether the whooping-cough had any effect upon the deafness in these two cases, but it is not improbable that the co-existence of two diseases, each of which may result in deaf-mutism, has been a factor of some moment. The following case is also worthy of mention.

Case No. 25. Anna N., daughter of poor cottagers who were not related to each other, and among whose relatives there were no cases of deafness, deaf-mutism, lunacy, &c., was born on July 19th, 1873. In 1877 she had scarlet fever, causing a very considerable degree of deafness, which, however, improved sufficiently for her to attend the parish school. In 1882 she had measles accompanied by purulent discharge from the ear, and deafness which was so considerable that shouting in the ear was inaudible. The hearing has not improved since, and utterance is monotonous and her stock of words small.

UNCERTAIN CAUSES.—It is well known that deafness resulting in deaf-mutism may appear without any pronounced symptom, and without it being possible to discover any cause even by the most careful examination. In such cases the most probable explanation seems to be that the deafness is the result of an abortive form of one of the infectious diseases which cause deaf-mutism, or that it is due to primary labyrinthine disease. It is possible, during epidemics of cerebro-spinal meningitis, to meet with such slight cases that the individual attacked exhibits very few symptoms; such cases may perhaps easily escape notice, especially when the individual attacked is an infant.

CHAPTER II.

MORBID ANATOMY.

Although a partial examination of the auditory organs of deaf-mutes during lifetime is possible, still it can only embrace the peripheral parts, and there must always be a difficulty in deciding whether the morbid changes thus revealed are of primary or secondary importance, or, indeed, only accidental. It is, therefore, only possible to arrive at an intimate knowledge of the morbid changes causing deaf-mutism, and hence, at a just comprehension of its nature, by means of post-mortem examinations. We have but few reports of such examinations dating earlier than the commencement of this century, and they yield so little information that we can only surmise that the examinations have been very incomplete.

Several careful autopsies of deaf-mutes date from the commencement of this century, but it was Ibsen's and Mackeprang's, Bochdalek's and Hyrtl's thorough and comprehensive examinations, made during the period from 1826 to 1840, that first gave a solid basis for our knowledge of the morbid anatomy of deaf-mutism. It is much to be regretted that Ibsen's and Mackeprang's dissections, including, in all, 55 cases, were but little known out of Denmark, probably because no full report of their results was ever published, and but few cases were added during the years immediately following their observations. Latterly an interest in the morbid anatomy of deaf-mutism seems to have revived, and has led to the increase of our knowledge of that particular anomaly, and also of the origin of labyrinthine diseases in general.

There exist, up to the present, 139 reports of post-mortem examinations yielding positive results, the principal of which are collected in an appendix to this book. The reports of these examinations and my own anatomical investigations form the material on which this chapter is based.

In treating of the morbid anatomy of deaf-mutism it would seem most natural to consider the congenital and acquired morbid changes separately. But here we are confronted by the difficulty of deciding in each instance, from the history of the case in question, how far the deafness has been congenital or acquired; indeed, in the majority of existing reports of dissections of deaf-mutes, all information as to the origin of the deafness is wanting. In post-mortem examinations it is also a matter of considerable difficulty, indeed, often of impossibility, to decide between congenital changes and those acquired after birth. I shall, therefore, in the following pages, consider each portion of the auditory organ separately, describing under each part, first the abnormalities which are most common in deaf-mutism in general, and then, so far as it is possible, I shall treat of the congenital and acquired changes separately.

Before discussing the different parts of the auditory organs in which morbid changes have been found, it must be observed that several investigators have found no changes whatever in some of the cases examined by them (IBSEN and MACKEPRANG, COCK, TOYNBEE, and others), indeed, IBSEN'S and MACKEPRANG'S investigations gave negative results in no less than one-third of all their cases. As, however, these investigations date from a period when the microscopic examination of the labyrinth was but little developed, and as no mention is made of an examination of the brain or of the auditory nerve, the negative results arrived at lose considerably in importance, for it is possible that the parts of the auditory organ above mentioned have been the seat of undetected abnormalities. After a minute examination of temporal bones of deaf-mutes, prepared by the late Professor IBSEN, I am, however, convinced that in many cases no changes are to be found in the osseous parts of the auditory organs of the deaf-mute [216, p. 264].

Finally, great care must be observed before we attach too great an importance to the changes found in the different parts of the auditory organs, for they may be purely accidental, or only variations.

MORBID CHANGES OF THE EAR.—These may be classified as those of the external ear, of the middle ear, and of the labyrinth.

THE EXTERNAL EAR AND EXTERNAL AUDITORY MEATUS.—Important congenital abnormalities of the external ear have never been discovered by post-mortem examination, but sometimes during lifetime (*see* below) unimportant congenital abnormalities of the auditory meatus, such as abnormal contraction and distension, have been found, while unimportant acquired changes, such as accumulation of cerumen, caries, &c., are comparatively frequent.

THE MIDDLE EAR.—The pathological changes of this part of the auditory apparatus may be divided into those which affect the walls of the tympanic cavity (including the drumhead), those which affect the contents of the tympanic cavity (auditory ossicles, chorda tympani, and the muscles of the middle ear, &c.), and finally, those which affect the parts connected with the tympanum: the antrum mastoideum with the processus mastoideus and the Eustachian tube.

The Membrana Tympani.—Abnormalities of this membrane, as found by otoscopic examination of living deaf-mutes, will be mentioned in another chapter. The drumhead is very often found, on post-mortem examination, to have been subject to morbid changes. In one case it was reduced in size [HYRTL, xcviii.*]. In some cases the membrana tympani was found to be in a somewhat horizontal position [MANSFELD, cii., and VOLTOLINI, cxxiv.]; in both instances the cause of deafness was unknown, and the other pathological changes discovered did not point to congenital origin. Abnormalities affecting the tension of the drumhead have been discovered several times, and are often accompanied by the formation of adhesions between the membrana tympani and the wall of the labyrinth. Perforations of the drumhead are particularly frequent, and so is its more or less complete absence, these changes being the expression of a previous suppuration in the tympanic cavity, the remains of which may also be seen in the form of scars and calcareous deposits. Bony deposits have also been found in the membrana tympani by J. G. Müller [lxxxviii.], and in one case observed by Moos [lvii.] it was entirely replaced by an osseous mass. This, and other evidences of suppuration of the tympanic cavity, are not only frequent in cases of acquired deafness, but also in congenital forms, a circumstance which is perhaps explicable upon the supposition I have previously advanced, viz., that the ears of deaf-mutes are very vulnerable [189, p. 71]. An undoubted congenital absence of the drumhead has never been found at the post-mortem examination of deaf-mutes. All the above-mentioned abnormalities have, of course, been of subordinate importance, for we know that even the complete absence of the drumhead is not of necessity accompanied by any considerable deafness.

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* Here and afterwards Roman numerals enclosed in brackets indicate the number in the list of post-mortem reports in the appendix.

The Labyrinthine Wall.—The changes in this part of the middle ear have especially affected the two windows, the round and the oval, and *the fenestra rotunda* and its immediate surroundings have been the most frequent seats of abnormalities. These have principally assumed the form of contractions of the fenestra [Hyrtl, xvi. and xcvii.; Bochdalek, xviii.; Dardel, xxx.; Gherini, cxi. and cxii.; Triquet, cxiv.]

filling up of the niche with fibrous tissue [Politzer, xxxv.; Voltolini, cxxii. and cxxiii.; Moos and Steinbrügge, cxxix.; Gradenigo, cxxxiv.], and also in changes of the *membrana tympanica secundaria*, which is found to be both increased and diminished in thickness, and in some cases more or less completely destroyed.—*The fenestra rotunda* is very generally wanting, or filled up by osseous masses, especially in cases of acquired deaf-mutism, while this is only occasionally so in congenital cases [congenital: Montain, vi.; Römer, xx.; Dardel, xxx.; Moos, xxxii.; acquired: Ibsen and Mackeprang, xliv.; Bochdalek, liii.; Schwartze, lvi.; Moos, lvii.; Uchermann, lxi.; Larsen and Mygind, lxiii.; Bryant and Sears, lxv.; Mygind, lxvi., lxviii. and lxix.; uncertain: Schallgruber, lxxix.; Cock, xcii. and xcvi.; Nuhn, ciii.; Gherini, cv.; Helie, cxvi.; Moos, cxxvii.]. In only one case was there any reason to suppose the closing of the fenestra rotunda (or, as the abnormality in this and several other cases is called *absence of the fenestra rotunda*) to have been a congenital deformity (Dardel's), the scala tympani being stated as opening into the vestibulum; on the opposite side there was found to be a contraction of the fenestra. In all the other cases there is reason to suppose that the closing of the fenestra was caused by an ossifying process, the result of inflammation, exceptionally only of undoubtedly fœtal origin, and most frequently arising after birth. This supposition is further supported by the circumstance, that the closing of the window by an osseous mass is very frequently accompanied by the traces of unquestionable inflammatory processes in the tympanic cavity. This seems also to indicate that the inflammation of the tympanic cavity has been the primary process, the abnormalities simultaneously discovered in the labyrinth being the remains of inflammation propagated from the tympanum through the fenestra rotunda. This explanation is at least indubitable in those cases where measles, or scarlet fever, are stated as being the causes of deafness, and also in a case observed by Moos, where "suppuration from the ear and caries of the mastoid process" were the causes, while in cases where brain-disease gave rise to the deafness it is possible that the inflammation followed the opposite course. The case which I observed, in which the power of hearing was not entirely destroyed in the one ear, although the fenestra rotunda was completely closed [lxviii.], proves that the closing of the fenestra does not necessitate absolute deafness. In the majority of cases also, in which the fenestra rotunda was wanting, there were found considerable morbid changes in the inner ear, consisting, as a rule, of osseous deposits in the labyrinthine cavity, especially in the cochlea. This, together with several of the above-mentioned circumstances, and others which will be treated of under the morbid anatomy of the labyrinth, and which prove that labyrinthine changes in deaf-mutes are often the result of inflammatory processes, justify us in supposing that the fenestra rotunda is the passage through which the inflammatory processes most frequently pass from the tympanic cavity to the labyrinth.—*The fenestra ovalis* was closed by an osseous mass in only about one-half the number of cases, the majority of which were the cases in which the fenestra rotunda was closed (MONTAIN, MYGIND's one case, BRYANT and SEARS, SCHALL-

GRUBER, GHERINI). In the remaining cases the fenestra rotunda exhibited no abnormalities [IBSEN, and MACKEPRANG, xliv.; HYRTL, xcviii.; MOOS and STEINBRÜGGE, cxxxiii.; DRAISPUL, cxxxviii.] HYRTL raises the supposition that the osseous plate closing the fenestra was, in the case observed by him, the base of the stapes, but in the other cases the bony mass seems to have been the result of an intense inflammatory process in the tympanic cavity. The history of the case and the morbid changes found, pointed in all the cases, except MONTAIN'S, to acquired ear-disease as the cause of the abnormality. A diminution of the fenestra ovalis was observed a few times; in these cases the above-described morbid changes implied that this abnormality was also the result of post-natal disease. It is further worthy of observation that the fenestra ovalis was sometimes closed by membranous formations. Finally, the niche of the fenestra ovalis was in one case found to be filled with fibrous tissue. While the above-mentioned abnormalities of the fenestra ovalis are of less frequency, the complete or partial anchylosis of the stapes is very common, as will be shown further on.

Anomalies of the Promontory (promontorium) have been observed in some few cases. Its absence is of interest in so far as it may be expected to be an expression of the absence of the cochlea, or at least of its first turn, while, on the other hand, the existence of the promontory in cases where the cochlea was absent might be considered to be a proof that the abnormality was not congenital. Reports of post-mortem examinations, however, in which the absence of the promontorium is mentioned [Hyrtl, xvi.; Römer, xx.; Schallgruber, lxxix.; Gherini, cx.] show that in one case only, viz., Schallgruber's, was the cochlea stated to be absent. The history of the case, and also the description of the results obtained, are so defective in this case that no certain conclusions can be deduced from it. On the other hand the cochlea is, in several cases, said to be absent (*see* below), while no mention has been made of the absence of the promontory. We cannot, therefore, attach any importance to the absence of the promontory in the question touched upon.

The Remaining Walls of the Tympanic Cavity.—Among the morbid changes of the remaining walls of of the tympanic cavity (besides such as concern the entrance to the Eustachian tube, which will be treated of later on) may be mentioned such as are the result of a more or less wide-spread inflammation of the tympanic cavity. Of such, the deposits of new formations of osseous masses which have been found in several cases, and which have more or less diminished the size of the tympanic cavity, are especially deserving of mention, and also the destruction of the walls of this cavity resulting from caries. There is, however, no necessity to go more closely into these abnormalities, as their importance is less as a direct cause of deaf-mutism than from the circumstance that they, together with numerous other anomalies found in the tympanic cavity of deaf-mutes (pus, detritus, cholesteatomateous masses, &c.), show plainly that the morbid processes which lead to deaf-mutism often have their seat in the middle ear, and also that they often are of such a nature that, in the majority of cases, the co-existent labyrinthine affection may, without difficulty, be interpreted as the result of the propagation of an inflammation from the middle ear.

The Contents of the Tympanic Cavity.—Abnormalities of the normal contents of the tympanic cavity (the ossicula auditus, muscles, &c.) often indicate past or existing destructive inflammatory processes. In some cases the tympanic cavity has been entirely void of its normal contents, and has been transformed into a large cavity only containing pus or a cholesteatomateous growth. These abnormalities, both according to the history of the cases in question and the general appearance of the morbid changes found, were the results of a suppuration of the middle ear, acquired after birth. *The complete absence of the ossicula auditus* is by no means uncommon in deaf-mutes. Although in many of these cases the deafness was said to be congenital, there is only one [MONTAIN, vi.] in which there is anything which supports the supposition that the absence of the ossicula auditus was the result of congenital malformation and not of a destructive process. In this case the labyrinth was entirely wanting, and the membrana tympani was present and "of natural appearance," while the Eustachian tube was normal. Although it is not very probable that the membrana tympani presented a natural appearance, considering that the malleus, which gives it a special character, was absent, still, on the other hand, it is improbable that a destructive process, such as a suppuration of the tympanic cavity, would have caused the total destruction of the ossicula, and would have spared the drumhead so much that its complete regeneration was possible. In this case, as in all the others, with the exception of two observed by Itard [lxxv. and lxxvi.], there were, co-existent with the absence of the ossicula, pronounced pathological changes in the labyrinth, and it is, therefore, highly probable that these were the principal causes of deafness in all the cases. In Itard's two cases, which it must be observed are very briefly reported and belong to a period when the methods of examining the ear were still very imperfect, no mention is made of abnormalities of the labyrinth, and it is, therefore, possible that the complete absence of the ossicula was the sole cause of deafness. —*Absence of the incus*, alone or in conjunction with absence of the malleus, is frequently observed, a circumstance which supports our clinical experience, viz., that the incus is the ossicle which is most often detached or destroyed in cases of suppuration of the middle ear, and further support is lent to this contention by the co-existing absence of the malleus in the majority of cases, where the incus was missing.—*Absence of the stapes* alone has been revealed in several cases. In some of the cases in which absence of either the stapes, the malleus, or the incus, or of both the malleus and the incus, is reported, the description of the pathological changes and their causes is so deficient, that it is impossible to form any opinion as to the nature of the absence of this ossicle. In a case published by Michel [xxix], the abnormalities described in the tympanum, in the inner ear, and especially in the petrous bone, all indicate that the absence of the stapes was the expression of a fœtal malformation. In all the other cases, where one or more of the ossicles was absent, the accompanying information, or the changes found in the tympanum, or both together, showed that the absence of the ossicula auditus was the result of a post-natal inflammatory process. It is naturally of great interest to ascertain what part the fenestra ovalis has played in the cases in which the stapes was missing. In MICHEL'S case no mention is made of the fenestra ovalis in the brief report; there is, however, reason to suppose that both it and the fenestra rotunda were missing, as there was a congenital absence of the inner ear. In only one case is any notice taken of this possible connection, viz., in one observed by HYRTL [xcviii.], in which the fenestra is reported as being closed by an osseous plate, possibly representing the base of the stapes. Finally, it would be interesting to determine how far the absence of the stapes is, in itself, capable of producing deafness serious enough to result in deaf-mutism. It is true that several reports of post-mortem examinations of deaf-mutes mention the absence of the stapes without referring to any labyrinthine changes, but all these cases are of such an early date and are so briefly reported, that no reliable conclusions can be deduced from them as to whether the absence of the stapes can in itself cause deaf-mutism.—*Atrophy of all the ossicula auditus* has been observed by many investigators, and has in all probability always been the expression of congenital malformation, among other reasons, because it is always found to be accompanied by other indubitably congenital anomalies. In two cases, those of BAILLY [iii.] and GHERINI [cix.], no mention is made of co-existent changes in the labyrinth.—*Atrophy of the malleus and the incus* has been observed by HYRTL [xvi.]; in this case only the stapes on the opposite side was atrophic. In this case other congenital malformations and also the history of the case, proved the individual in question to have been a congenital deaf-mute.—Among *other abnormalities of the ossicula auditus* may be mentioned certain malformations of the stapes, in particular the non-union of either or both crura stapedis to the capitulum or base, or their complete absence, and the entire or partial absence of the base of the stapes has also been observed occasionally. These changes may owe their origin to either fœtal or post-fœtal processes.—*Anchylosis of the ossicula auditus* is without doubt the abnormality of this part which is most frequently discovered at the post-mortem examinations of deaf-mutes. This is not so remarkable when we remember that the tympanic cavity of deaf-mutes often is, or has been, the seat of intense inflammatory processes. The anchylosis of the plate of the stapes in the fenestra ovalis is, of course, of the greatest interest, and this has been found to occur in about one-eighth of all the dissections. This anchylosis is only in a few cases stated to be due to synostosis, in the remainder it has doubtless been of fibrous nature. As the total or partial anchylosis of the stapes in the fenestra ovalis is an important cause of the progressive deafness, which is peculiar to certain forms of chronic catarrh of the middle ear, often developing into complete deafness, it would seem, at first sight, that the frequent existence of this abnormality in deaf-mutes bears some resemblance to the conditions which are present in chronic catarrh of the middle ear. A close investigation of the cases in question, however, shows first, that in several instances besides the anchylosis of the stapes in the fenestra ovalis traces have been found of very pronounced inflammatory processes of the tympanic cavity, and further that in the majority of cases there existed considerable labyrinthine changes, which have doubtless been the principal cause of deafness. Only in the cases observed by CRAIGIE [xlix.], GHERINI [cx.], TRIQUET [xxv.], POLITZER [xxxv.], and LARSEN-UTKE [xxxvi.], labyrinthine changes are mentioned, or is there a decided statement that none such existed. A critical investigation of these cases proves, however, that TRIQUET's case referred to an idiot, and it is not, therefore, improbable that pathological changes in the brain were the cause of the deafness. In LARSEN-UTKE's case, which was that of a totally deaf child, there was no microscopic examination of the membranous labyrinth, or, I believe, of the auditory nerve. It appears also that CRAIGIE made no examination of the labyrinth, and the objection may be also raised that GHERINI's case, as reported by ED. SCHMALZ, was an examination of the dry specimen. Thus, POLITZER's case alone remains as a presumably valid proof of anchylosis of the stapes being capable of producing a degree of deafness so considerable as to result in deaf-mutism. In conclusion, it is worthy of mention that anchylosis of the stapes is just as frequent in cases of acquired as it is in congenital deaf-mutism.

The Muscles of the Tympanic Cavity.—Abnormalities of these muscles are frequent, sometimes in connection with some of the above-mentioned anomalies of the ossicula, especially those in which the malleus and incus are absent, sometimes in connection with a wide-spread destruction of the normal contents of the tympanic cavity, and sometimes without any such connection. They have generally consisted in the entire absence of the muscles and in various forms of degeneration (principally atrophy and caseous degeneration). It must, however, be especially pointed out, that various investigators have not been able to discover any degeneration of the muscles of the tympanum even in cases where the organs of hearing may be supposed to have been out of function for years. An explanation of this circumstance, which seems in opposition to the rules which generally apply to muscles, is, perhaps, that the sound-conducting apparatus continues to act, even when the nervous apparatus has ceased to do so.—*Absence of the chorda tympani* is sometimes mentioned as an abnormality of the middle ear in deaf-mutism, apart from the above-mentioned cases in which all the normal contents of the tympanum were absent, Triquet [xxv.], Michel [xxix.], Bochdalek [liii.]. In Bochdalek's case, the cause of the absence of the chorda tympani was probably a destructive inflammatory process which had its seat in the tympanic cavity; in Triquet's and Michel's, which were both cases of congenital deafness, there is reason to suppose that the chorda tympani, if it existed at all, had followed another course than through the tympanum.

The Mastoid Process.—As the tympanum of deaf-mutes is so often the seat of inflammatory processes, or their remains, it is but natural to suppose that the same would be found in the mastoid process. On closer observation, this will also be found to be the case. There is, however, no occasion to go more minutely into the abnormalities which have been discovered, as these, as a rule, refer to secondary processes propagated from the tympanum (such as destruction of the normal cavity, sclerosis of the bone, closing of the antrum, filling by pus, cholesteatomateous masses, &c.), and are of no direct importance as a cause of deaf-mutism. There is only one abnormality which it is necessary to speak of more particularly, viz., *the absence of the mastoid process*. This anomaly is described by MICHEL in a case [xxix.] in which there were numerous other congenital malformations which proved without doubt this anomaly to be a result of arrested development. As the whole labyrinth was wanting in this case, absence of the mastoid process has been sought for as a proof of the absence of the inner ear. Later dissections, in which the inner ear has been found to be missing, have not, however, proved the absence of the mastoid process or any diminution in its size.

The Eustachian Tube (tuba Eustachii).—Morbid changes of this part of the middle ear have been found several times. The above remarks referring to the mastoid process hold good here also, and there is, therefore, no reason for a lengthy description. It may, however, be mentioned that the tympanic aperture of the Eustachian tube has been sometimes found to be blocked up by osseous substance or fibrous tissue—changes which have doubtless been caused by new formation of tissue as a result of inflammatory processes.—

Besides the above-mentioned pathological changes of the different parts of the middle ear in deaf-mutes, various others have been found on post-mortem examination; such as abnormal fibrous adhesion between the walls of the tympanum, between the walls and the ossicula auditus, and between the ossicula themselves, further, partial carious destruction of the ossicula, atrophy of the membrana tympani, &c., &c. There is, however, no necessity to enter more particularly into these abnormalities, partly because they offer nothing characteristic of the morbid anatomy of deaf-mutism, and partly because they must be considered as of secondary importance with regard to the deafness. They have sometimes been unilateral, but in the majority of cases have been found in either ear.

If we take a survey of the pathological changes of the middle ear which have been found by the post-mortem examination of deaf-mutes, we shall find that such changes are remarkably frequent. It is only exceptionally that these have been the results of malformation, but have in the majority of cases owed their presence to inflammatory processes, or the remains of such. These inflammatory processes have sometimes been of catarrhal nature, but generally suppurative, in which cases they have been intense and destructive. The abnormalities which are characteristic of the morbid anatomy of deaf-mutism have had their seat about the two fenestræ, especially in and around the fenestra rotunda, which has exhibited anomalies in not less than one-fourth of all the dissections which have yielded positive results, and has in particular been frequently closed by osseous masses. In the majority of cases, however, the abnormalities of the middle ear have been accompanied by marked morbid changes in the inner ear.

THE LABYRINTH.—Morbid changes of this section of the auditory organs have embraced either the whole labyrinth or only parts of it. The so-called *entire absence of the labyrinth* plays an important part among the former class, partly on account of its comparative frequency and partly on account of its origin. Unilateral or bilateral absence of the labyrinth has been observed by MONTAIN [vi.], MICHEL [xxix.], SCHWARTZE [lvi.], MOOS [lvii.] and MYGIND [lxviii.]. The majority of authors have hitherto considered the absence of the labyrinth to be the result of arrested development, and this opinion has been strongly supported by SCHWARTZE and MOOS in their reports, although the history of the cases distinctly pointed to an acquired deafness. I have, however, in several of my works [187, 188, 198 and 214] proved that partial or complete absence of the labyrinth, or of parts of it, may be, and probably most frequently is, caused by the deposit of osseous tissue in the labyrinthine cavity, which becomes thus more or less completely filled up, under which process the normal outlines may disappear entirely. Such a formation of osseous tissue is without doubt the result of a previous imflammatory process, that is, of an *otitis intima*. I have at the same time pointed out that it is often impossible to distinguish between fœtal and post-fœtal morbid changes by post-mortem examination, unless this is accompanied by exhaustive and reliable information as to the cause and date of the affection. From the following, it will be evident that the deposit of osseous tissue in the cavity of the labyrinth is one of the most frequent labyrinthine anomalies found upon post-mortem examination of deaf-mutes, the osseous mass sometimes filling the whole cavity, while sometimes only a single section exhibits a parietal deposit which has merely caused a slight diminution of the cavity in question. The most extensive formations of osseous tissue in the labyrinth are apparently the result of a post-natal *otitis intima*. It is interesting to observe that various investigators have discovered such osseous tissue, sometimes on the one side only, sometimes on both, some having also found osseous tissue on the one side, and deposits of chalk or fibrous tissue—which may also, as is well known, be the result of inflammatory processes—on the other side, and both the latter deposits have also been frequently discovered in the labyrinths of deaf-mutes when there was no formation of osseous tissue on either side. Inflammatory and also degenerative processes may leave other products behind them, which may appear in like manner in other parts of the body. Among these the following are especially worthy of notice: caseous masses, which in one case (HAIGHTON'S) completely filled up the labyrinth, pigment, and round cells. I would not, however, imply that the partial or complete absence of the labyrinth may not be the result of arrested development, which, on the other hand, may be due to fœtal inflammatory processes. Still, it is often difficult to find perfectly valid proofs that such has been the origin of the abnormalities in individual cases. A case observed by MICHEL [xxix], is, however, doubtless of this nature, as the petrous bone was entirely deformed, exhibiting two surfaces, a superior and an inferior, thus presenting a flattened appearance; the auditory nerve was also absent, to which circumstance the non-development of the labyrinth was doubtless due, as it is not probable that the terminal organ of a nerve would develope when the nerve itself was absent. When we further take into consideration that the petrous part of the temporal bone to a great extent developes its characteristic form by depositing its osseous substance outside the labyrinth, the outline of which is plainly visible in the fœtus, and even in newly-born infants, we shall understand the reason why the petrous bone was so greatly deformed in the case observed by MICHEL; and it seems as if we might be justified in expecting important malformations of the labyrinth to be reflected in the shape and appearance of the petrous bone. So far as the other cases are concerned, it may be observed that MONTAIN's referred to an individual said to have been born deaf, but it is only briefly reported by SAISSY, who only states that "the vestibule, the stapes, both the aquæductus and the fenestra ovalis were wanting entirely." The history in the remaining cases, on the other hand, proves that the ear-disease was acquired after birth, in all cases between the ages of three and four, the cause having been respectively, inflammation of the brain, discharge from the ear, with caries of the mastoid process, and scarlet fever. All the above-mentioned cases exhibited a complete absence of the labyrinth on one or on both sides, not the least trace of a cavity remaining. In three other cases there were some rudiments of the natural cavity. In one of the latter [HELIE, cxvi.] a canal was found on the right side in the place of the vestibule, opening into the posterior surface of the petrous bone, probably representing the aquæductus vestibuli; on the left side was found a true vestibule filled by a soft white mass. In the second case [MOOS and STEINBRÜGGE, cxxix.] a small cavity filled with fatty globules and fibrous tissue was found on either side in the place of the vestibule, and on the right side there was a slight trace of the semicircular canals and the cavity of the cochlea. In the third case [IBSEN and MACKEPRANG'S, xxxix., the specimens are in the Pathological Museum of the University of Copenhagen] the absence of the labyrinth is, it is true, described by MACKEPRANG as being complete, but I have, on examining the specimens, found a small cavity corresponding to the vestibule, and on the left side a cavity corresponding to the first turn of the cochlea [216, p. 247]. The history of the cases and the post-mortem investigations of the organs of hearing distinctly show the manner in which the inflammatory processes originate, the final products of which we have seen above and shall often meet with in the following pages. In the case above mentioned in which I discovered complete absence of the labyrinthine cavity on account of its being filled by osseous masses [lxviii.], there exists information which proves that the primary cause in this case was suppuration of the middle ear, arising during scarlet fever, and still present at the time of dissection, having produced widespread and intense destruction of the middle ear. This case may be supplemented by numerous others, in which, however, the formation of osseous tissue in the labyrinth has not been nearly so extensive, but which all prove that the *otitis intima*, which gave rise to the formation was secondary to the inflammation in the middle ear. According to the reports of several post-mortem examinations the inflammation of the middle ear was due to acute infectious diseases, in particular scarlet fever and measles. In conformity with the above it will be seen that in dissections, in which the complete or partial absence of the labyrinth was discovered, tolerably well-marked changes were found in the middle ear, consisting in great part of remains of inflammatory processes, and the same was true of many of the cases which will be mentioned below as examples of circumscribed deposit of osseous substance in the labyrinth. On the other hand, the absence of inflammatory process in the middle ear, or the traces of such, and in other cases the histories of the cases seem to indicate that the labyrinthine inflammation is not of necessity propagated from the middle ear, but that it frequently originates in the membranes of the brain. This is especially probable in all cases where meningitis is stated with certainty to be the cause of deafness, and which are mentioned on p. 130. There is perhaps a third kind of labyrinthine inflammation, viz., primary inflammation, which has been especially defended by VOLTOLINI and called after him *otitis intima of Voltolini*. The existence of this affection cannot be proved, or disproved, by arguments drawn from the material here under discussion. It cannot be proved because so long a time has always elapsed between the post-mortem examination of a deaf-mute, and the date of the appearance of the ear trouble, as to render it possible for all traces of an inflammation of the brain or middle ear to have entirely disappeared. On the other hand, the existence of Voltolini's *otitis intima* cannot be denied, as the products of inflammation in the middle ear found at the same time as remains of labyrinthine inflammation, may be entirely casual. In connection with this description of morbid changes affecting the entire labyrinth, it may be observed that Nuhn found in a case examined by him [ciii.] an entire *absence of the membranous labyrinth*. In this case, which is not accompanied by any history, but which, from the evidence of numerous malformations, was congenital, it is probable that the membranous labyrinth was never developed, as the auditory nerve was missing, and replaced by nerve filaments going from the facial nerve to the vestibule.

The Vestibule.—The vestibule (with the exception of its aquæductus) is that part of the labyrinth which has been least frequently found to be the seat of morbid changes. The reason is that the vestibule (the aquæductus always excepted) is, comparatively speaking, seldom found to be abnormally changed on post-mortem examination of *deaf-born* deaf-mutes, anomalies in the two other principal sections of the labyrinth being twice as frequent in these cases. It is also remarkable that in no hitherto published post-mortem examination of a deaf-mute with acquired, or congenital deafness, or where the origin of deafness is not stated, has the vestibule been the only section of the labyrinth which has been the seat of abnormalities, the other sections being also changed when this has been the case with the vestibule. Finally, the changes found in the vestibule of deaf-born deaf-mutes have not exhibited any such peculiarities as to point to an arrest of development, but have, as a rule, presented the same appearance as in cases of acquired deafness. Undeniable evidences of malformations were found in only two cases of individuals, the origin of whose deafness was unknown. In the one case [Hyrtl, xcvii.], in which the other morbid changes also indicated a congenital affection, the fenestra rotunda opened into the vestibule; in the other, examined by Scheibe [cxxxvii.], numerous microscopic abnormalities were discovered, which he considered to be malformations. It is also probable that Cock's [xcix.], Nuhn's [ciii.], and Michel's [xxiv.] cases, in which the vestibule was extended outwards so as to include the place of the external semicircular canal, which was wanting, are results of malformations. There is, then, reason to suppose that the congenital morbid changes most frequently found in the vestibule of deaf-mutes on post-mortem examination, are, on account of their resemblance to those found by similar examinations of deaf-mutes with acquired deafness, the result of inflammatory processes, as such is the origin of post-natal labyrinthine changes. The abnormalities otherwise found in the vestibule have either affected the osseous cavity, or its membranous contents. So far as the former are concerned we have already seen that the vestibule, together with all the remaining parts of the labyrinth, may be filled by osseous or calcareous masses, by fibrous tissue, or other products of inflammatory processes, into the nature and origin of which it is not necessary to enter more particularly. The same formations have been found in the vestibule in cases where the remaining parts of the labyrinth were partially or completely filled by such products, and in some few cases the vestibule alone was found to be entirely or partially filled by them. Sometimes, however, the osseous mass deposited has been so slight, as to only somewhat diminish the natural cavity of the vestibulum. In some cases the cavity has been diminished by other means, viz., by thickening of the periosteum, the origin of which abnormality is doubtless the same as that just described. On the other hand, the vestibule has also, in several cases besides the above, been more or less distended, which condition is most easily explained as being the result of a destructive process.—*Pathological changes of the membranous contents of the vestibule* have been observed frequently. They have principally consisted of thickening of the sacculi and deposits of various products in their walls and cavities. These formations were principally colloid corpuscles, masses of otoconia, accumulation of pigment, calcareous concretions, caseous matter, detritus, &c., products which, both from their nature and origin, must, for the greater part, be considered as the results of inflammatory or degenerative processes. In NUHN's case the membranous contents of the vestibulum have also been found missing [THURNAM, xcv.; MANSFELD, cii.].

The Aquæductus Vestibuli.—Besides the above-mentioned cases in which the vestibule was missing, and in which it may be supposed, or is stated that the aquæductus also was missing, or blocked up, this

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The Aquæductus Vestibuli.—Besides the abovementioned cases in which the vestibule was missing, and in which it may be supposed, or is stated that the aquæductus also was missing, or blocked up, this abnormality is mentioned by Cock in a case where the vestibule was only distended [xcix.]. The distention of the aquæductus vestibuli is, on the other hand, not uncommon. Ibsen, who has most frequently observed this abnormality, makes it the subject of especial mention, and states that he has never found it, on post-mortem examination of deaf-mutes, together with morbid changes of the vestibule, but always in connection with pronounced abnormalities of the cochlea, which remarkable circumstance he makes use of to prove that the aquæductus vestibuli is in much more intimate relation with the cochlea (towards which it is continued in the shape of a furrow) than with the vestibule [140, p. 52]. Ibsen's statement is confirmed by all hitherto published reports of post-mortem examinations of deaf-mutes, in so far that the vestibule has not exhibited any abnormality in a single case in which the aquæductus vestibuli was distended. So far as the cochlea is concerned, it is true that it, along with the remaining parts of the labyrinth, was in some few cases found to retain its natural condition, but in the majority of cases in which the aquæductus was extended, it, and in some few cases also the semicircular canals, was the seat of pronounced changes. Although in two cases [Ibsen and Mackeprang, vii., and Dalrymple, xci.] the distension of the aquæductus vestibuli was the only abnormality found in the ear, we are not justified in supposing that this anomaly was the cause of deafness in the cases in question, as the aquæductus vestibuli does not belong to the sound-perceiving section of the labyrinth. It is, on the contrary, probable that there were in these two cases changes present, as in many others yielding a negative result, which escaped observation. Neither can the distension of the aquæductus vestibuli in the remainder of the cases be considered as other than of secondary importance, it being, however, difficult to decide the origin of this abnormality. In congenital cases it is possible that the distension of the aquæductus vestibuli has something to do with the part which that canal plays in the development of the labyrinth during fœtal life ; in cases of acquired deafness it is possible that, as the aquæductus vestibuli is continued into the subarachnoideal space, the inflammatory process has been propagated direct into the labyrinth by this route. The latter may also be the case where the post-mortem reports point to a fœtal meningitis—a form of inflammation of the brain which is perhaps no rare cause of congenital deafness. HABERMANN is also of opinion that a distension of the aquæductus vestibuli may be caused by increased pressure, resulting from hydrocephalus, especially when the petrous bone is the seat of rachitic changes. It cannot, however, be denied, that the distension of the aquæductus vestibuli found on post-mortem examination of deaf-mutes may possibly represent nothing but an unimportant variety. This question can only be solved by comparing the results of examinations of deaf-mutes with the results of similar examinations of normally hearing individuals.

The Semicircular Canals.—These are decidedly that portion of the labyrinth which is most frequently the seat of pathological changes, which are indeed so frequent as to have been found in more than half of the dissections yielding positive results. Indubitable cases of congenital malformations have been observed by several investigators, but it is questionable whether such abnormalities as the union of two canals into one, shortening or lengthening of the canals, &c., are to be considered as of vital importance. The abnormalities which have been found in the semicircular canals of deaf-mutes concern either their osseous parts or membranous contents. We have already seen that the semicircular canals, together with the entire portion of the labyrinth, may be filled with osseous or calcareous masses, with fibrous tissue, or other products of inflammatory processes, the nature and origin of which have been discussed. Besides this, the semicircular canals have sometimes been affected in this way at the same time as another part of the labyrinth, most frequently the cochlea. In some cases the canals alone have been the seat of morbid changes. In the latter case all the canals, or some of them, or only a part of a single one, has been affected. In not less than one-fifth of all the dissections yielding positive results, the semicircular canals were the only part of the labyrinth which exhibited morbid changes. This is surprising when we remember that Ewald's experiments proved that the function of the semicircular canals is more closely connected with the so-called *tonus-labyrinth* and less (perhaps not at all) with the *hearing-labyrinth* [209, p. 298]. In the majority of cases in which the semicircular canals have been the seat of abnormalities, they, or a part of them, have been filled up by osseous tissue, or must be supposed to have been so in the many cases where the reports simply mention "absence" of these canals. Besides, the easiest explanation of such abnormalities as the "absence of a semicircular canal," the "closing of a semicircular canal," &c., is, that the canal in question has been filled by an osseous mass, which has so much resembled the surrounding bone in consistency and appearance, that the normal outlines have been unrecognisable; and abnormalities which are described as contractions of the canal are most naturally interpreted as being the result of deposits of osseous substance along the inner surface of the canal in question. I have been persuaded of the justice of this explanation by examining all the preparations which comprise a large collection of temporal bones of deaf-mutes belonging to the Pathological Museum of the Copenhagen University [216]. There are to be found, in this collection, indeed often in a single specimen, numerous transitions from partial contractions of a single canal to the complete closing of all, and from the distinct appearance of the outlines of the canals to a complete obliteration of the same. A closer investigation of the cases in literature, in which a deposit of osseous masses has been found in the semicircular canals, or in which this must be supposed to be the case, shows that in the majority of cases this pathological formation has affected all the canals, cases in which only a single canal was affected being in the minority. It shows also that in cases where only one or two canals have been the seat of the above-mentioned abnormality, the posterior canal has most frequently been attacked, either alone or together with another, which in most cases has been the superior, with which it is also in direct connection. The frequency with which the posterior semicircular canal is the seat of osseous deposits, is, perhaps, connected with the circumstance that its ampullar orifice is the lowest of all the openings to the semicircular canals, and also that it is nearest to the fenestra rotunda; the fenestra rotunda, as above mentioned, playing an important part as an entrance for labyrinthine inflammatory processes. It may be mentioned, finally, that the filling of the semicircular canals with osseous masses has been found in deaf-mutes with congenital and also with acquired deafness, the seat and appearance of the abnormality not differing in these two groups. Now, as there is reason to suppose, according to the circumstances above pointed out, that the deposit of osseous substance in the semicircular canals (as in other parts of the labyrinth) is the result of an inflammation, there is great likelihood that the same formations found upon post-mortem examination of deaf-born deaf-mutes are due to the same cause, and must, therefore, be considered to be the products of fœtal inflammatory processes. The circumstance that these inflammatory processes are not nearly so widespread or intense as post-fœtal, may be looked upon as explaining the fact that fœtal osseous deposits in the semicircular canals of deaf-mutes are not nearly so extensive as post-fœtal deposits, which often occupy all the canals, or the greater part of them.—*Morbid changes of the membranous semicircular canals* have been frequently discovered. They have most often been entirely wanting; or hypertrophy or atrophy of their walls has been found. Besides which, there have been discovered various formations, such as masses of otoconia, accumulation of pigment, &c., which must be considered to be the products of inflammatory or degenerative processes.

The circumstance that the semicircular canals are that part of the labyrinth which is most frequently found to be the seat of morbid changes in deaf-mutes, and also that these changes are often confined to the semicircular canals alone, is, as already mentioned, remarkable, when we consider what a secondary part the canals probably play in the function of hearing. It may be that remains of labyrinthine inflammation from some cause or other, for instance, on account of the narrowness of the canals, is most easily organised and microscopically detected in this part of the labyrinth. It must also be observed that a great number of the post-mortem examinations of deaf-mutes date from a period when microscopical investigation was but little developed, as it is also more or less certain that in many of the autopsies, both earlier and later, no microscopical examination whatever was attempted. Finally, it is evident from numerous reports of palpable changes of the osseous labyrinth, that little or no attention has been paid to the membranous labyrinth. It seems, therefore, that there is no reason to suppose the frequent occurrence of abnormalities of the semicircular canals to be a frequent *cause* of deaf-mutism, but only a conspicuous proof of the frequency with which labyrinthine inflammations are the origin of that anomaly. The abnormalities discovered in the semicircular canals point also in another direction when it is remembered that it is an approved fact that disturbances of the equilibrium are very common among deaf-mutes. In this respect post-mortem and clinical observations of deaf-mutes speak strongly in favour of the theory of the influence of the semicircular canals on the equilibrium of the body—a theory which has lately found such support in Ewald's eminent work [209].

The Cochlea.—Morbid changes of the cochlea are somewhat more frequent than those of the vestibule, and are pretty equally divided between congenital and acquired cases of deaf-mutism. In several cases the cochlea was the only part of the labyrinth which was the seat of morbid changes; in the great majority of cases, however, other parts of the inner ear have been abnormal, the semicircular canals having been at the same time especially frequently the seat of anomalies. I was formerly of opinion that morbid changes which were the undoubted expression of malformations and of abnormalities caused by arrest of development, were comparatively frequent in the cochlea [189, p. 55]. I was induced to form this opinion from the circumstance that several investigators stated that they had found the cochlea, in cases of congenital deafness, to consist of only one or one-and-a-half turns, and also because Ibsen (in whose preparations of the temporal bones of deaf-mutes this abnormality is present several times) mentions the malformation as an undoubted result of arrested development [140, p. 53]. A more minute examination of a number of specimens belonging to the Ibsen-Mackeprang collection of temporal bones, and the observation of a case of my own, not yet published [cxxxix.], caused me to alter my former views. I found, namely, that in all the cases in which the description of the specimen only mentioned the commencement of the cochlea as being present, there was a cavity corresponding in size and shape to the rest of the interior of the cochlea, and in this cavity there were in several cases distinct traces of the formations which, under normal circumstances, are to be found in the capsule of the cochlea, in particular, remains of the modiolus and of the partition walls which bound the cavities formed by the turns. My own case greatly resembled those referred to above. It is also evident, if we consider the history of the formation of the cochlea, that an arrest of development at a period when only one turn is formed, would result in a short and flat cochlea, resembling in shape and appearance KÖLLIKER's drawing of the cochlea of an eight-weeks'-old human fœtus [fig. 449, p. 725, in his "Entwickelungsgeschichte," 129]. The existence of a cavity in the top of the cochlea, corresponding in size and shape with the normal cochlea, plainly indicates that all the turns have been present, but that their normal partitions, and also the modiolus, with its belongings, have been destroyed. That this destruction is the result of a fœtal inflammatory process seems probable, and the circumstance that the commencement of the turns of the cochlea is able to resist destruction, is explained by the fact that this part of the cochlea is earlier consolidated and ossified than the other parts. It seems, therefore, doubtful whether the cases which are reported in literature as exhibiting a cochlea of only one or two turns with a large cavity at the extremity [MONDINI, iv.; IBSEN and MACKEPRANG, x., xiii., xvii., and lxxx.; HYRTL, xcviii., and COCK, xcx.]

are the results of arrest of development, although two of Ibsen and Mackeprang's specimens were the temporal bones of a brother and sister. Römer's case [xx] is, on the other hand, an undeniable example of arrest of development, as Römer states that the canal of the cochlea only formed 1¾ turns round the modiolus, which reached to the top of the cochlea, the whole length of which, from base to top, was 1¾ lines, while, as Römer declares, a normal cochlea measures 2½ to 3½ lines. Cases in which the whole interior of the cochlea forms one large cavity [Triquet, xxvi.; Hyrtl, xcviii.; Cock, c., and Nuhn, ciii.] would seem to be related to the above-mentioned cases, in which a large cavity is discovered in the upper part of the cochlea. No trace, or only a very slight trace, of the normal osseous contents of the cochlea was found in these cases, which all belonged to persons who were either stated to be born deaf, or supposed to be so on account of the co-existence of indubitable malformations. It is not possible to decide how far the so-called "deficient development of the lamina spiralis" (*i.e.*, that the lamina does not extend throughout the whole interior of the cochlea) is the result of an arrest of development [Hyrtl, xvi.]. The few cases in which the scala tympani is reported as opening into the vestibulum are undoubtedly an expression of malformation [Mansfeld, cii., and Dardel, xxx.]. Mansfeld's case affords no information as to the state of the fenestra rotunda, but there is every reason to suppose that it has been absent or has been closed in one way or another. The more or less entire filling up by osseous or calcareous masses is the anomaly most common to the cochlea, and under this heading may doubtless be included all cases in which the cochlea is reported to be entirely absent, or in which only one or two small cavities remained. Abnormalities of this nature are mentioned in about one-eighth of all hitherto published post-mortem examinations. There is no occasion to dwell again upon the origin of osseous or calcareous formations; here, as in the semicircular canals, they are most frequently met with in cases of decided, or supposed acquired, deafness. The parts nearest to the top of the cochlea are the seat of the osseous deposit in the great majority of cases in which the cavity of the cochlea has only partially been filled up, while in no small number of cases the first turn has been entirely, or partially preserved. The cochlea has also been found to be filled up by other pathological products, partly of uncertain origin, partly the result of inflammatory or degenerative processes, for instance new formations of connective tissue, round cells, caseous products, accumulation of otoconia, colloid corpuscles, detritus, &c. These formations have been found either singly or several at the same time, sometimes also in connection with new formations of osseous tissue. Finally, the pathological changes have now and then been confined to *the membranous contents of the cochlea*, which in some few cases (besides that mentioned p. 155) have been entirely, or partially absent, while the osseous structure of the cochlea has been preserved almost, or quite entirely. Among other morbid changes confined to the membranous contents of the cochlea may be mentioned atrophy of the nerves and of the ganglion cells in that part of the labyrinth, in some few cases they have also been partially wanting. In a single case [Scheibe, cxxxvii.] various anomalies of formation were discovered by microscopical investigation.

In only a few cases have the above-mentioned anomalies been confined to the cochlea alone, in the great majority abnormalities have at the same time existed in the other parts of the labyrinth, especially in the semicircular canals and the auditory nerve. The anomalies found in the cochlea of deaf-mutes can, as has been frequently pointed out, for a great part be traced back to fœtal, or post-fœtal inflammatory processes, which have often been both widespread and intense. The large number of cases in which the middle ear also exhibited traces of inflammation prove that these processes are not confined to the labyrinth alone. Our knowledge of post-natal acquired infantile labyrinthine affections, which are connected with diseases of the middle ear, authorises us to suppose that in most cases the latter are primary processes, and there is, therefore, much which speaks in favour of the supposition, that the abnormalities so frequently found in the cochlea of deaf-mutes, especially of deaf-mutes with acquired deafness, are the result of an inflammation which has been propagated from the middle ear. On the other hand, the circumstance that abnormalities in the cochlea are not unfrequently found without the co-existence of destructive processes, or the remains of such, in the middle ear, indicates that inflammatory processes of the cochlea may also originate in other ways. The history of several cases points out clearly in this respect, that propagation from the membranes of the brain plays an important part (*see* p. 111). In all the cases in which the cause of deafness was meningitis, or a disease with the same symptoms, all the other parts of the labyrinth were morbidly changed, and it is, therefore, impossible to decide by which channel the inflammation has entered the cochlea, especially whether it has been through the foramina cribrosa, which, from a theoretical point of view, would seem to offer an easy access to inflammation.

The Aquæductus Cochleæ.—But few reports of post-mortem examinations of deaf-mutes make any mention of morbid changes of the aquæductus cochleæ, although it has doubtless been filled up by osseous substance, when such has filled up the whole of the cochlea. An abnormality described by Ibsen and Mackeprang, consisting of an expansion of the external orifice of the aquæductus cochleæ, which was situated on the posterior surface of the petrous bone, must doubtless be considered as unimportant.

MORBID CHANGES OF THE AUDITORY NERVE.—These are frequently found on post-mortem examination of deaf-mutes. *The complete absence of the nerve*, which has been twice proved, is particularly interesting. In the one case [Müller, lxxxviii.] it is briefly mentioned, that "the auditory nerve is wanting"; as no mention is made of abnormalities of the labyrinth, nor of any examination of the origin of the nerve, it seems very doubtful whether this is a case of congenital anomaly. In MICHEL's case [xxix.], which is described somewhat exhaustively, there was no trace of the auditory nerve right up to the interior of the fourth ventricle. The meatus auditorus internus was reduced to a narrow canal which served as a passage for the facial nerve, and the labyrinth was utterly lacking in the deformed petrous bone [*see* p. 179]. There is no doubt that this is an example of congenital complete absence of the auditory nerve, and it is most natural to suppose, that it is the very absence of the nerve which has caused the non-development of the labyrinth. In a way, NUHN's case [ciii.] can also be reckoned among instances of complete absence of the auditory nerve. In this case, in which no information could be obtained as to the cause of deafness, but in which the existing morbid changes clearly indicated a congenital affection, the auditory nerve was completely wanting from the fourth ventricle. In the inner auditory meatus there were, however, two thin nerve filaments, which seemed to have their source in the otherwise normal nervus facialis, and which proceeded to the vestibulum, where their further course could not be traced; NUHN supposes these filaments to have been the only remains of the auditory nerve. There was no abnormality of the labyrinth which could indicate an arrest of development. BOCHDALEK has twice observed an abnormality which may also be considered as congenital, namely, that the nerve became much attenuated after having sent a thick bundle of nervous fibres to the facial nerve [xviii. and li.]. Finally, congenital abnormalities have in some cases been found at the origin of the nerve. In one of these cases the auditory nerve originated with one root from the corpus restiforme, in another also with one root, but from the middle line of the fourth ventricle [Ackermann, lxxi.]. In the last mentioned case there was no trace of the existence of the striæ acusticæ, which was also absent in a case observed by Meyer [cxviii.], who, however, does not consider it as a malformation, but as the result of a fœtal meningitis causing a thickening and shrivelling of the ependyma. Finally, Politzer found the striæ acusticæ but slightly developed [xxxiv], and in a case of Schultze's they were entirely absent on one side [lxii.]. As to the importance which is to be attached to the absence of the striæ acusticæ, it must be remembered that they may be wanting in individuals with normal hearing, and their absence does not, therefore, necessitate deafness, unless, as Meyer supposes in the above-mentioned case, they have existed, and have been destroyed by an inflammatory process. The most frequent morbid change of the auditory nerve is *complete or partial atrophy or degeneration* of its trunk or branches. In not less than 17 cases, published up to now, the microscopical examination has discovered undoubted signs of, or the microscopical examination has substantiated, atrophy or degeneration of the trunk or branches of the auditory nerve, *i.e.*, in about one-eighth of all post-mortem examinations which have given positive results. Besides these, in ten other cases the microscopical appearance of the auditory nerve has been such as to justify the supposition that the auditory nerve has been atrophied, or degenerated. In these cases the auditory nerve has been described as thin, firm, hard, &c.

It is, however, worthy of notice, that Michel, in a case observed by him, found the auditory nerve hard, whilst the microscopical examination discovered no change in it [xxiv.]. In the cases of atrophy of the auditory nerve microscopically examined by Voltolini, it was, on the other hand, proved that a firm consistence of the nerve was due to a hyperplasia of the connective tissue of the nerve, co-existent with atrophy of the nervous elements. The nerve, or part of it, has in many cases presented a gelatinous appearance, and the degeneration has been so intense that a portion of the nerve looked pulpy. Finally, in a single case [Schwartze, lvi.] in which the changes of the organs of hearing could be referred to a post-natal inflammation of the brain, the circumstance that the auditory nerve exhibited no ramifications in the floor of the internal auditory meatus is most easily explained by supposing that the terminal branches were entirely destroyed. It may also be mentioned, that the atrophy of the auditory nerve was sometimes confined to a particular terminal branch, or to a part of the trunk, which corresponded to the distribution of certain terminal branches. Thus Larsen and Mygind [lxiii.] found that only the vestibular branch and its continuation in the trunk of the auditory nerve were atrophied. Scheibe [cxxxvii.] found that only the branch to the sacculus and to the ampulla of the posterior semicircular canal, the so-called ramus posticus Retzii, was atrophied, and Bochdalek found the atrophy confined to the cochlear branch [li.]. As a sign of degeneration may be brought forward, the appearance of the so-called corpora amylacea and of calcareous concretions in and around the auditory nerve, which formations have been found in some few cases.

It will then be seen, that although atrophy and degeneration of the auditory nerve, or a part of it, are frequent in deaf-mutes, they are far from being always present, as believed by many, since HYRTL put forward that supposition, based upon post-mortem examinations performed by him [80, p. 228]. As it is to be supposed that the auditory nerve of the majority of deaf-mutes examined post-mortem has been out of function for some time, without there being found any atrophy or degeneration in it or its branches, it would seem that this nerve is not particularly disposed to become atrophied or degenerated from inactivity. The correctness of this hypothesis is confirmed by morbid anatomical examinations hitherto published of persons who have become deaf at a more advanced age, which examinations all point in the same direction.* The cases of atrophy or degeneration of the auditory nerve which have been found by post-mortem examination of deaf-mutes, seem, therefore, as a rule, to be due to some other cause, and we are obliged to consider them as the result of either centripetal atrophy or degeneration subsequent to labyrinthine destructive processes, or as the expression of a centrifugal change arising from primary disease of the central nervous system. In support of the latter hypothesis it must be observed that the degeneration of the auditory nerve was, in nearly all the cases, bilateral, although frequently differing in character, and particularly in intensity, on either side. A closer examination of these cases shows, however, that there was also a bilateral *labyrinthine* change, which may perhaps as reasonably be supposed to be the cause of the anomalies of the auditory nerve. Several cases where the labyrinth is described as being perfectly normal, but where the auditory nerve was atrophied, or degenerated, speak in favour of centrifugal degeneration. Although the examination of the labyrinth in many of these cases was evidently deficient, there is still reason to suppose that centrifugal degeneration was the cause of the atrophy in at least some of them. Finally, the circumstance that the central nervous system has, in some instances, exhibited certain morbid changes which might give rise to degeneration of the auditory nerve, speaks in favour of a descending degeneration of the auditory nerve. Thus, COCK [xix.] describes a case of congenital deafness in which the auditory nerve was thin and hard, and in which the cochlear branch was wanting on the right side; the brain was hard, COCK speaking of it as being caseous. In one case, without any history, ROSENTHAL also found the consistence of the auditory nerve unusually firm, and at the same time discovered signs of internal hydrocephalus in the central nervous system, and an abnormal hardness of the medulla oblongata [lxxii.]. Finally, in MEYER'S above-mentioned case, in which there was no information as to the origin of the deafness, a thickening of the ependyma of the floor of the fourth ventricle was discovered. In the majority of the reports of post-mortem examinations of deaf-mutes with atrophy or degeneration of the auditory nerve, or part of it, mention is, however, made of extensive labyrinthine affections, all of which extended to the whole, or the greater part, of the inner ear, and they also were, as a rule, the expression of severe destructive processes, which, in most of the cases, doubtless were, or were supposed to be, of post-fœtal origin. There seems, therefore, to be reason to suppose that the atrophy or degeneration of the auditory nerve so frequently exhibited by deaf-mutes, is in many cases due to a degenerative process arising in the labyrinth. It must, however, be remembered, that there is another possible explanation of the cases in which both auditory nerve and labyrinth were the seat of morbid changes, namely that both anomalies may be the direct result of a past, but no longer traceable, inflammation of the membranes of the brain, which as previously mentioned, may produce very pronounced labyrinthine abnormalities, which, in the majority of the cases published [*see* p. 113], were also accompanied by morbid changes of the auditory nerve. That traces of inflammation are but seldom found in the membranes of the brain upon post-mortem examination of deaf-mutes, does not at all affect this latter hypothesis, since it is a well-known fact, that the most severe inflammation of the membranes of the brain can no longer be traced in cases where post-mortem examination of the individual in question takes place some time after recovery from the meningitis.

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* It is true that HABERMANN has recently proved, by a series of very minute examinations, that atrophy of the nerves in the inner ear is very common in deaf persons, which abnormality he is inclined to consider as the result of inactivity. It seems, however, to be the exception for atrophy to extend centripetally from the labyrinth to the trunk of the auditory nerve.

It is, therefore, impossible as yet to give any satisfactory reason why the auditory nerve of some deaf-mutes becomes atrophied or degenerated, while in others it does not. The question will doubtless be cleared up by a larger number of new post-mortem examinations of deaf-mutes, accompanied by reliable information as to the origin of the deafness.

MORBID CHANGES OF THE CENTRAL NERVOUS SYSTEM.—These have been entirely confined to the cerebrum, the cerebellum, and the medulla oblongata. Morbid changes of these parts of the central nervous system have, with the exception of quite accidental affections, been but seldom found upon post-mortem examination of deaf-mutes, and their importance as causes of deaf-mutism is for the greater part of doubtful character.

THE FOURTH VENTRICLE (*Ventriculus Quartus*).—Morbid changes of the floor of the fourth ventricle have, so far as they affect the origin of the auditory nerve, already been mentioned [p. 171]. Besides these, MEYER has discovered the above-mentioned abnormality of the ependyma, consisting partly of flat and partly of knob-like thickenings, which extended through all the cavities of the brain and the cerebellum, and which in several places, especially in the floor of the fourth ventricle, had occasioned a shrivelling up of the underlying nerve tissue. As the auditory nerve in this case was remarkably firm and white, it is possible that the cause of the total deafness was to be sought in the atrophy of the nerve, at least at its origin, where the striæ acusticæ were included in the shrivelling process above mentioned. It is hardly possible to attribute any importance as a cause of deaf-mutism to the cystic degeneration of the arachnoidea in the floor of the fourth ventricle, which has been observed in a single case [Hyrtl, xvi.], especially as there was also atrophy of the auditory nerve.

THE CEREBELLUM.—Morbid changes of the cerebellum have been proved to be present by Oppolzer and Dlauhy [xxiii.], who found this part of the central nervous system to be the seat of atrophy in a man deaf from birth, who also exhibited signs of slight feeblemindedness. In this case, however, in which no abnormalities of the organs of hearing were discovered otherwise, it is reasonable to suppose, that both the deafness and imbecility were the result of other undiscovered abnormalities of the brain, as nothing is known as to the importance of the cerebellum in the function of hearing.

THE BRAIN *(cerebrum)*.—Morbid changes of the brain have been discovered by Luys twice. The one case was that of a man 72 years of age, who had been deaf from birth [xxxi.]. The cortex of the brain in many places around the cuneus (situated in the parietal lobe) was atrophied, yellowish, exhibited colloid degeneration, and was œdematous, and there was also found atrophy of the nerve fibres from that part down to the thalamus opticus. In the second case, which was that of a boy of 14, as to the origin of whose deafness nothing was known, Luys found atrophy of the cortex of the brain in the posterior convolutions (in the parietal lobe?), hyperplasia of the neuroglia in the anterior part of the tractus opticus, thickening of the walls of the fourth ventricle, and also serous infiltration of the origin of the auditory nerve [cxxviii.]. From these two cases, Luys drew the conclusion that the region about the cuneus contains an acoustic centre, the degeneration of which causes deafness. As a part of the temporal lobe is generally considered to be the seat of an acoustic centre, LUYS' cases must be looked upon as somewhat doubtful, especially as he had made no examination of the labyrinth (or auditory nerve ?). The defective development of the surface of the third convolution and of the insula Reilii of the left side, may be mentioned, finally, as an abnormality several times discovered in deaf-mutes, but which has no causal relation to the deafness. This anomaly has been observed by RÜDINGER [143, p. 27], WALDSCHMIDT [177, p. 374], LARSEN and MYGIND [lxiii.], and BRYANT and SEARS [lxv.]. The two first-mentioned investigators found this abnormality in several deaf-mutes as to whose history there was no information, and whose labyrinths were not examined, while the other investigators found it in two deaf-mutes, who had both become deaf after birth, in the third year, after meningitis and scarlet fever respectively, and who both exhibited pronounced abnormalities in the ear. The above-mentioned flattening of the cerebral convolutions is doubtless due to atrophy, caused by inactivity of the parts of the brain which are known to be the motor centre of speech, on account of the inactivity of the muscles of speech. In the two latter cases also, there was information proving that the deaf-mutes in question had never learnt to speak.

MORBID CHANGES OF THE PETROUS BONE.—As the petrous bone is so closely related to the labyrinth, both topographically and also with regard to its development, it seems natural to expect frequent morbid changes of this part. Such have been found in several cases. Michel's case of congenital abnormality of the petrous bone, which has been frequently mentioned before, is particularly interesting, as it seems to be an undeniable example of the deficient development of the petrous bone resulting from the non-development of the fœtal labyrinth. Michel describes this abnormality as presenting itself immediately upon the opening of the cranium, the normal sharp division between the middle and posterior cerebral fossæ, formed by the superior edge of the petrous bone, being absent, the petrous bone itself being completely flattened, so that, instead of the usual three, it presented only two faces, one superior facing the cerebrum, and one inferior. The superior face, which was slightly convex, was divided into an anterior and posterior part by a large furrow, in which a vein was embedded. In the posterior part was an oval opening, about two millimetres wide, representing the internal auditory meatus; in this was the facial nerve, while the auditory nerve was completely absent. Smaller irregularities in the construction of the petrous bone have been observed several times, and in several cases it has been found to be abnormally large, while in one it was diminished in size. One abnormality is, in conclusion, worthy of mention, viz., a deficient deposit of osseous substance upon the outer surface of the posterior semicircular canal, which was thus left completely or partially bare upon the posterior face of the petrous bone, being only covered by the dura mater. This abnormality has only been mentioned by Hyrtl [xvi.], but as I recently made the same discovery when examining the organs of hearing of a deaf-mute, whose deafness was supposed to be congenital [cxxxix.], I examined IBSEN and MACKEPRANG's specimens in the Pathological Museum of the Copenhagen University, and found the same abnormality in two cases [vii. and lxxx.], the one of which was undoubtedly, and the other probably, a congenital deaf-mute. This, and the above-mentioned congenital anomalies of formation of the petrous bone, are not important as causes of deafness, but as pointing, together with other abnormalities, to fœtal processes as being that cause. Such anomalies of the petrous bone are, therefore, of great importance in cases where reliable and complete information as to the origin of deafness are unattainable. It must, however, be remembered that anomalies of formation of the petrous bone may be purely accidental. One of the most frequent morbid changes of the petrous bone is an abnormal hardness, or complete sclerosis of the whole or part of the bone. This abnormality has been found in individuals with both congenital and acquired deafness. It is most probably the result of an osteitis, which it, therefore, appears may be of both fœtal and post-fœtal origin. This anomaly has without doubt been present in other than the cases where it is particularly mentioned, namely, in such in which the place of the labyrinth is described as being of solid osseous tissue. In a few cases the structure of the petrous bone was loose and cellular.—Certain *abnormalities of the meatus auditorius interna* are finally worthy of mention. The most frequent is a contraction of the same. It is difficult to decide as to the importance of this abnormality how far it is only a variety, or whether it is related to the processes causing deafness. In all cases it seems to have been congenital. In one of IBSEN and MACKEPRANG'S cases, the meatus auditorius internus was greatly distended [lxxxiv.], and in another it formed a flat groove [ix.]. Finally, abnormalities have been frequently observed in the floor of the meatus auditorius internus, the normal fine openings existing there for the transmission of the terminal branches of the auditory nerve (foramina cribrosa) being absent in the cases in which the cochlea was filled up by osseous substance (*see* above).

MORBID CHANGES OF THE LARYNX.—These play an important part in earlier reports of post-mortem examinations of deaf-mutes, many authors making mention of "gaping of the glottis," "diminished size of the laryngeal cavity," &c., and some few considering such abnormalities as being the principal, or even the sole causes of deaf-mutism, in the cases in question. It is hardly necessary to add that such opinions were based on preconceived incorrect views as to the causes of deaf-mutism, and that atrophied, or similar conditions of the larynx, were caused—if they really existed—by the comparative inactivity of the larynx of deaf-mutes.

MORBID CHANGES OF OTHER ORGANS.—Of these, mention may be made of congenital deformity of the cranium, and other malformations. These abnormalities are of course of importance in doubtful cases, their existence indicating that the changes in the organs of hearing have been congenital. Tuberculous affections of the various organs, in particular of the lungs, have been most frequently discovered upon post-mortem examination of deaf-mutes. It is not, however, correct to infer from this, or from the circumstance that deaf-mutes frequently die of tuberculosis, that their lungs, from not being used in speaking, are especially liable to this disease, or that they are altogether delicate. This will, however, be treated of more fully further on.

If we cast a retrospective glance over the foregoing pages, it will be seen, first, with regard to the nature of the morbid changes met with in the hearing organs of deaf-mutes, that they do not differ, so far as their quality is concerned, from those generally found in ear-diseases, but that the difference must rather be sought in the intensity and extent of the morbid processes. The abnormalities found in deaf-mutes may, namely, in a great number of cases, be most naturally interpreted as being the residuæ of intense and widespread inflammatory processes. This is particularly evident in cases referring to deaf-mutes who had become deaf after birth. It will further be seen, that the abnormalities found in cases of congenital and acquired deafness often present exactly the same appearance, so that in many cases it is impossible to decide, from the post-mortem examination alone, whether the changes are of fœtal or post-fœtal origin. It is thus evident that the formerly accepted opinion, that deaf-mutism arising from congenital deafness was due to congenital malformations of the auditory organs, has not been corroborated, since abnormalities which are the indubitable expression of such malformations are but seldom met with. So far as the seat of the abnormalities is concerned, it was found that these were, as a rule, bilateral, but have often differed greatly on either side, both as to character and localisation, and especially as to intensity. The few cases in which the principal abnormalities were confined to the one side, while the other was normal, or only the seat of unimportant anomalies, must, for the present at least, be looked upon with some suspicion. Finally, it has been proved that the middle ear has very frequently been the seat of changes, accompanied, however, as a rule, by important abnormalities in the inner ear. These were most frequently situated in the semicircular canals, least frequently in the vestibulum, and were in many cases to be considered as the principal cause of deafness. The auditory nerve in many cases exhibited signs of atrophy and degeneration, and a few other abnormalities, while in a considerable number of cases no changes were visible. In some few cases the brain deviated somewhat from the normal.

Deaf-mutism is, therefore, from an anatomical point of view, in most cases to be considered as a result of an abnormality of the labyrinth.

CHAPTER III.

SYMPTOMS AND SEQUELÆ.

SYMPTOMS.—Of these the principal are, of course, deafness and dumbness, but other symptoms closely connected with the ear-disease causing deafness are often met with in cases of deaf-mutism.

DEAFNESS.—The term deafness is not only used to express the absolute absence of hearing—*total deafness* as it will be called in the following pages—but also to express a condition in which some traces of hearing remain, but in which the human voice is not audible in the usual way—a condition described as *partial deafness* [189, p. 3]. From a theoretical point of view it seems an easy matter to make a sharp distinction between the condition in which the auditory nerve is entirely out of function and that in which it still acts, though deficiently. As a matter of fact, however, it has been proved that it is sometimes difficult to decide, in particular cases, whether there are any remains of hearing or not, and also that the results of these two conditions, that is, if they are congenital or acquired in early childhood, are the same, viz., the morbid condition known as deaf-mutism. In other words, both individuals with total deafness, and individuals with partial deafness, may be met with among deaf-mutes.

ITARD distinguished between the different degrees of hearing possessed by deaf-mutes [31, vol. ii., p. 407]. He formed five classes, viz., (1) hearing of speech (*l'audition de parole*), (2) hearing of the voice (*l'audition de la voix*), (3) hearing of sound (*l'audition des sons*), (4) hearing of noises (*l'audition des bruits*), and (5) absence of hearing (*audition nulle, ou surdité complète*). KRAMER has six classes [97, p. 331] and TOYNBEE as many as seven [86, p. 409]. Such classifications are, of course, arbitrary, and it is often difficult to draw a correct line of demarcation. It seems most natural to arrange deaf-mutes according to their power of hearing in two classes, as is done in Denmark, viz., deaf-mutes with total (*true deaf-mutes*) and deaf-mutes with partial deafness (*semi-mutes*), [*see* p. 9]. This classification is of great practical value, as it can be made use of in determining the fitness of the deaf-mutes for different forms of instruction.

It is not always an easy matter to test and decide the amount of hearing possessed by a child, especially an infant. As a rule, only ordinary loud sources of sound can be employed to discover whether the child in question reacts in any way to the sound produced, for instance, by turning, or blinking its eyes. Generally a loud whistle, a bell, clapping of the hands, or such-like devices, are made use of. Such a rough mode of examination can, however, only decide whether the power of hearing exists or not in individual cases, and even this is often difficult when the patient is an infant, and it is also no easy matter to determine whether the power of hearing is equal on both sides. With older children it is easier to discover whether the power of hearing exists, and if so, in what degree. In the latter case less powerful sources of sound may be employed. Of these the principal is the tuning-fork, the vibrations of which are used in measuring the conduction of sound through the middle ear by placing it outside the ear, and also in measuring the so-called bone or cranio-tympanic conduction, by placing it on the mastoid process or on the teeth. The human voice is also an important means of investigation. The best way of employing it is to pronounce certain vowels loudly and distinctly close to the deaf-mute's ear without his being able to see the movement of the mouth, the patient being desired to repeat the vowels pronounced. To prevent the possibility of guessing, the vowels should be pronounced several times. If the deaf-mute understands the vowels easily, consonants and even words and short sentences may be tried. In most cases this method can only be made use of when the deaf-mute in question has learned to articulate. A greater power of hearing is seldom met with, unless sound-increasing instruments are employed. The hearing of deaf-mutes with considerable remains of hearing can also be tested with a loud-ticking watch placed outside the ear, or pressed against the outer ear. It is, however, very unusual for deaf-mutes to be able to distinguish the high notes represented by the ticking of a watch. In employing all these methods it must be borne in mind that the hearing of deaf-mutes in some cases differs greatly at different times, according to varying conditions in the ear, of which we have no immediate knowledge.

Literature contains reports of a number of investigations as to the power of hearing possessed by deaf-mutes, all of which refer to pupils in deaf and dumb asylums. It is, however, somewhat difficult to compare the results arrived at, since the different investigators have employed different sources of sound, and consequently have classified the deaf-mutes in different ways. There is, however, one group which is on the whole clearly defined, viz., the totally deaf deaf-mutes, and it is the numerical strength of this group which offers the greatest interest. The reports of various investigators, as to the relative number of deaf-mutes with total deafness, differ considerably. HARTMANN, who collected all the reports published up to 1880, found that 60·2 per cent. of all deaf-mutes were entirely without any power of hearing [132, p. 86]. The figures, however, upon which HARTMANN'S work is based, vary considerably, and this has also been the case with reports published later, HEDINGER calculating the number of absolutely deaf as being 72·1 per cent. [144, p. 25]; H. SCHMALZ, 21·4 per cent. [161, p. 157]; LEMCKE (in Ludwigslust), 20·8 per cent. [171, p. 11]; UCHERMANN, 30·3 per cent. [168, p. 74]; BULL, 21·0 per cent. [178, p. 753]; PLUDER, 30·5 per cent. [196, p. 572]; and LEMCKE (in Mecklenburg-Schwerin), 43·7 per cent. [210, p. 209].

Three circumstances account for the discrepancies in the results arrived at by different investigators. The first is that different modes of investigation have been employed. Thus, TOYNBEE describes all children as totally deaf who were unable to hear clapping of the hands; Hartmann, such as were unable to hear a loud dinner bell; and Hedinger, all such as were unable to hear the so-called Galton's whistle, and so on. Secondly, the boundary line between children with extreme deafness and deaf-mutes is arbitrary (*see* p. 2), and consequently the rules of admittance to the different asylums vary somewhat. Finally, the principal cause of the discrepancies is, perhaps, to be sought in the fact that there is generally a distinct relationship between the degree of deafness and the cause of that deafness. This latter circumstance will be gone into more exhaustively in the following pages, and mention will also be made of the different degrees of hearing possessed by partially deaf deaf-mutes.

The relationship between the different degrees of hearing and the causes of deafness will be most distinctly seen by comparing the power of hearing of congenital deaf-mutes, as found by the various investigators, with that of deaf-mutes with acquired deafness. All investigators, namely, with the exception of Lemcke and Uchermann, have found a greater number of cases of total deafness among deaf-mutes with acquired deafness than among deaf-mutes with congenital deafness, the difference being in general very considerable, as will be plainly seen by Table X.

The reason why so many more cases of total deafness are met with among deaf-mutes with acquired deafness than among those with congenital deafness, is doubtless owing to the fact that post-natal processes in the ear causing deafness, are much more destructive than the same processes occuring during fœtal life, a circumstance which has been pointed out in Chapter II. Most authors have also

TABLE X.—TOTAL DEAFNESS IN DEAF-MUTES WITH ACQUIRED AND CONGENITAL DEAFNESS.

Investigator.	Locality.	Cases of Congenital Deafness.	Totally Deaf among the former.	Per cent.	Cases of Acquired Deafness.	Totally Deaf among the former.	Per cent.
Toynbee .. .. [86, S. 414]	London	313	172	55·0	98	73	74·5
Kramer .. .. [88, S. 331]	?	27	10	37·0	18	13	72·2
? .. .. [132, S. 86]	Baden	60	27	45·0	131	105	80·1
Hartmann .. Ibid.	Berlin	51	24	47·0	149	86	57·7
Hedinger .. [144, S. 25]	Würtemberg and Baden	181	117	64·6	234	182	78·0
Schmaltz.. ..[161, S. 157]	Dresden	39	11	28·2	148	24	16·2
Lemcke .. .. [171, S. 11]	Ludwigslust	20	4	20·0	37	7	19·0
Uchermann .. [168, S. 47]	Norway	132	41	31·0	201	61	30·3
Lemcke .. ..[210, S. 208]	Mecklenburg	199	79	39·7	246	118	48·0

found that congenital deaf-mutes are more frequently in possession of a considerable degree of hearing (hearing of vowels or even of words) than deaf-mutes with acquired deafness. Thus TOYNBEE found among 313 congenital mutes 82, *i.e.*, 26·2 per cent., with the power of hearing vowels or even more, while there were only 12, *i.e.*, 12·2 per cent., with the same degree of hearing among 98 deaf-mutes with acquired deafness; HARTMANN found 20·0 and 16·1 per cent. respectively; H. SCHMALZ, 23·6 and 20·4; UCHERMANN, 18·0 and 16·0; and LEMCKE, 8·5 and 8·1 per cent.

The discrepancy which exists between the various reports of investigators as to the number of deaf-mutes with acquired deafness who could hear vowels, &c., and especially between the number of those of the same category who were totally deaf, is doubtless explained by the circumstance that the destruction of the organ of hearing caused by the different post-natal diseases resulting in deaf-mutism varies in degree, and also that these diseases appear with unequal severity in different localities and at different times. We are not, however, in possession of much information upon this subject, TOYNBEE and HEDINGER alone making any mention of it. TOYNBEE found but little difference between the frequency with which scarlet fever, "fever" and "other diseases," caused total deafness. HEDINGER, on the other hand, found total deafness in 27 out of 32 deaf-mutes with deafness caused by epidemic cerebro-spinal meningitis, *i.e.*, 84 per cent.; in 25 out of 35 with deafness caused by scarlet fever, *i.e.*, in 71 per cent.; and in 54 out of 77 with deafness caused by "brain-disease" (inflammation, convulsions, &c.), *i.e.*, 70 per cent., but only in 50 out of 86 cases with deafness caused by other diseases, *i.e.*, in 58 per cent. A critical survey of the official reports of deaf-mutes with acquired deafness in Denmark during the year 1879–90 (*see* p. 45), yields a result which is, in some respects, similar to HEDINGER'S, inasmuch as 85 out of 133, *i.e.*, 64 per cent., cases of deaf-mutism caused by brain-diseases and scarlet fever (which two diseases did not differ much from each other), were reported as cases of total deafness, while this was the case in only 44 of 75 cases of other origin, *i.e.*, in only 59 per cent. As brain-diseases and scarlet fever contribute the largest contingent to acquired deaf-mutism (see p. 112 and following), the two last-mentioned investigations may perhaps hint that the diseases which least frequently result in deaf-mutism cause the least destruction of the auditory organs, while the opposite is the case with the diseases which most frequently lead to that abnormality. The latter supposition is confirmed by the circumstance that all post-mortem examinations of deaf-mutes, whose deafness was due to brain-disease or scarlet fever, have exhibited signs of extensive destruction of the organs of hearing (*see* previous chapter).

URBANTSCHITSCH [221] has observed a singular phenomenon, viz., that children, who had previously reacted to no sound whatever, after having been subjected to certain acoustic exercises, were capable of hearing. Should this be confirmed by other investigators, there will be reason for placing the number of true deaf-mutes at a still lower figure than that quoted above.

It may also be mentioned that several authors have found a different degree of hearing in either ear, which circumstance is also in accordance with the results yielded by post-mortem examinations of deaf-mutes (*see* p. 183).

LEMCKE has made a very interesting discovery, according to which, the later a deaf-mute child is born in a marriage producing several deaf-mute children, the greater will be the power of hearing it possesses, the eldest children being generally either totally or almost totally deaf [210, p. 210].

MUTISM.—Mutism was in early times believed to be the essential symptom of deaf-mutism (*see* p. 3), but is now known to be a secondary phenomenon, which is the consequence of the deafness, and which in some cases can be entirely removed. There are, however, reasons for supposing that the mutism is not always the result of the deafness, but that it may appear co-ordinately with the latter, being caused by the same morbid process. *Aphasia*, which term comprises various conditions accompanied by the loss of speech, appears sometimes as a symptom independent of deafness, being either congenital or acquired after birth, in the latter case, resulting from the action of some brain-disease upon the centre of speech. From a theoretical point of view then, in both acquired and congenital deaf-mutism, the mutism may be, in some cases, a symptom co-ordinate with the deafness, and consequently there may be cases in which it is impossible to remove the mutism by any method of education.* The reason also why many deaf-mutes never learn to articulate properly, in spite of unimpaired intelligence and persevering efforts, is perhaps that the centre of speech has been injured at the same time that the disease in the organs of hearing made its appearance. Future post-mortem examinations of deaf-mutes will probably throw more light upon this question, and especially supplement the few cases hitherto reported in which decided atrophy of the parts of the cortex about the third left frontal convolution and the insula have been found (*see* p. 178), these parts of the brain containing nervous centres of great importance for speech. Future investigators will perhaps be also able to decide whether the deficient development of the above-mentioned parts of the brain is the result of the non-development of speech by special methods of education, or whether the original cause of disease is the active element in this respect also.

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* Besides the two above-mentioned possibilities as to the cause of the co-existence of aphasia and deafness, there is perhaps a third, viz., that an infant with aphasia, which has not yet been discovered, may be attacked by deafness.

There is, however, no doubt that in the great majority of cases mutism is the direct result of the deafness. That this is the case is evident, as the degree of mutism is, as a rule, in exact relation to the degree of deafness and also to the period at which the deafness makes its appearance. Thus, congenital deafness, or deafness acquired in infancy, is always accompanied by complete mutism (excepting in cases in which the mutism is removed by special methods of instruction), while in cases of acquired deafness in which the deafness is either not total, or arises after the child has learnt to speak, a certain degree of speech is respectively acquired or retained. The explanation is simple, speech being, under normal circumstances, acquired through the ear, the child imitating the words which it hears spoken by those about it. It may, however, be mentioned, that even children totally devoid of hearing, produce sounds which somewhat resemble words, such as "mam-ma," "ba-ba," &c., and sometimes also imitate animals, often thus causing their friends to suppose that they are capable of hearing. This may be because the above-mentioned sounds and the voices of certain animals are produced by very simple movements of the vocal organs which can be imitated by spontaneous observation. Finally, it is possible that the vibrations caused by such loud sounds as the barking of a dog, bellowing of a cow, &c., may be perceived by the aid of touch, which sense is often highly developed in deaf children, and consequently guides them in imitating the sounds.

The question as to the degree of deafness which must exist, or in acquired cases, the age at which the deafness must appear in order to cause mutism resulting in deaf-mutism, cannot be answered decidedly. To begin with, the application of the term deaf-mutism is entirely arbitrary in cases in which there is some power of hearing or of speech, and the distinction between a deaf-mute child and a child with deficient power of hearing must, in some cases, depend entirely upon practical considerations, of which the method of instruction which is requisite for the child's education is, as a rule, decisive. Thus, for instance, a child of well-to-do parents, who is able to hear tunes, and to a certain extent reproduce them, will scarcely be considered deaf and dumb, and be sent to an asylum, while a child with the same degree of hearing, but of poor parents, will be treated as a deaf-mute, because the parents are unable to give it the special education which it requires. The non-development or deficient development of the power of speech in cases of congenital partial deafness, and its complete or partial loss in cases of acquired deafness, are also often dependent upon the assiduity with which a child's friends attend to its development or preservation. Some children, too, seem to have a greater aptitude for developing or retaining the power of speech than others, and this seems to be not only dependent upon their intellectual faculties but also upon other unknown conditions. Thus, a child with comparatively very slight power of hearing, or with deafness acquired soon after birth, may exhibit a comparatively considerable power of speech, while another child with greater powers of hearing and later acquired deafness may be entirely without it.

Future investigations will in all probability decide how far total acquired deafness results in total mutism. HARTMANN states that deafness acquired before the age of seven, as a rule, causes secondary mutism [132, p. 74], and this opinion is no doubt correct. On the other hand, according to Table IX., there are reports from various places to the effect that deaf-mutism may appear at the age of 14 or 15, or even later. In these cases, however, it is probable that the term deaf-mutism is incorrect, although of course such accidental circumstances as feeble-mindedness, blindness, &c., may necessitate the registration of individuals, who have lost the power of hearing so late in life, as deaf-mutes, because they are unable to read from the lips, or unable to pronounce so distinctly that they can be understood.

As frequently mentioned above, mutism in deaf-mutes may be either total, *i.e.*, the power of speech may be entirely wanting, or it may be partial, in which latter case, the power of speech is developed, or, in acquired deaf-mutism, it is retained to a certain extent. This power of speech is frequently considerable, so that such individuals cannot, properly speaking, be termed mutes. There are, however, certain peculiarities which always attach themselves to the speech even of persons who are only partially deaf from their birth, or who have become deaf during childhood. These peculiarities, which are still more pronounced in true deaf-mutes, consist in the absence of accentuation of syllables, and of words, the result being that speech becomes monotonous. Besides this, the speech of such persons is generally dull-sounding and feeble, and the control of respiration is also often deficient. The stock of words is also sometimes limited, though this peculiarity is, under ordinary circumstances, not very noticeable, excepting in cases where the power of hearing is very slight, or where the deafness appears comparatively early. These physical deficiences in the speech of deaf-mutes are easily accounted for, for the power of hearing is not only important in the development of speech by enabling a child to imitate the speech of others, but it also enables it to regulate the modulation, sound and force of its voice by the aid of the vibrations which reach the labyrinth through the bones of the cranium.

The power of hearing plays so great a part in the above-mentioned physical qualities of speech, that its loss cannot be completely compensated for by any other sense. It is, however, possible, by the aid of sight and touch, to teach a great number of deaf-mutes to speak well enough to be able to use speech as a means of communication. Individuals who have been totally deaf from birth can also be taught, by a special method of instruction, to speak so that they can be understood, although with the peculiarities above-mentioned. Owing to these peculiarities such speech has received the name of *articulation*. It is not always an easy matter, however, for the deaf-mute to retain the power of speech which has been acquired with so much difficulty, when he comes out into the world and constantly comes in contact with persons who cannot, or can only partially, understand him. In such cases the deaf-mute generally abandons the use of speech as a means of communication, especially as lip-reading (which is learnt at the same time as articulation) requires great attention and well-developed sight.

Having discussed the principal symptoms of deaf-mutism (deafness and mutism), there will now be occasion to go more particularly into other symptoms or phenomena, which are more or less closely connected with deaf-mutism or the morbid processes which give rise to it.

SUBJECTIVE EAR-SYMPTOMS.—But little attention has until now been paid to such symptoms, probably because deaf-mutism was not formerly so generally recognised as most frequently being the result of a pathological condition of the ear, as is the case at present. *Noises in the ear*, *pains in the ear*, and perhaps other dysæsthetic symptoms, and also *disturbances of the equilibrium* are among the subjective ear-symptoms which would doubtless, if made the object of especial investigation, be found in a great number of deaf-mutes. The disturbance of the equilibrium is the only group of ear-symptoms, however, which has been more fully treated of in literature.

Noises in the Ear.—Hedinger is of opinion [144, p. 126] that noises in the ear are very frequent in deaf-mutes, but that, owing to the difficulty with which reliable information is obtained, they seldom come to the knowledge of the observer. Person alone makes a distinct statement on this subject, which is to the effect that the majority of deaf-mutes examined by him post-mortem, complained during life of buzzings in the ears [68, p. 325].

Disturbances of the Equilibrium.—There seems to be every reason for including that group of phenomena known as disturbances of the equilibrium under ear-symptoms, partly because such disturbances frequently accompany ear-disease, and partly from the fact that certain parts of the labyrinth, and especially the semicircular canals, play an important part in maintaining the equilibrium of the body. It has been already mentioned that acquired deafness is often accompanied by disturbances of the equilibrium both at its first appearance and immediately afterwards, and that this complication is most frequent in cases where the deafness has been caused by cerebro-spinal meningitis [p. 114]. Mention is also made in literature of some few cases of congenital deafness accompanied by disturbance of the equilibrium consisting in uncertain and staggering gait, both during the first years of childhood [Mygind, 189, p. 72] and later in life [Hedinger, 144, p. 120]. Hedinger found this symptom in no less than 6 per cent. of the congenital deaf-mutes examined by him in the deaf and dumb institutions of Baden and Würtemberg, but only in 2 per cent. of the deaf-mutes with acquired deafness in the same establishments. H. James, Pollak, and Kreidl make a more exhaustive mention of the disturbance of the equilibrium and other phenomena connected with the equilibration of the body. James was the first to draw attention to *immunity from dizziness* under circumstances which otherwise produce dizziness and consequent disturbances of the equilibrium [151], which is characteristic of deaf-mutes. He examined altogether 519 deaf-mutes and found that 186, *i.e.*, 36 per cent., did not feel the least dizziness when spun round rapidly, no matter in what position their heads were placed. James was also informed by many of these deaf-mutes that they experienced a remarkable feeling of helplessness and want of sense of locality when under water, several of them also stating that these sensations were unknown to them before the loss of hearing. Kreidl endeavoured to discover, in a more rational manner, and by the aid of a specially constructed apparatus, an objective proof of the existence of the above-mentioned phenomena in deaf-mutes, and also to decide their nature and strength [197]. The result of these investigations was as follows. By turning the deaf-mutes experimented upon rapidly round a perpendicular axis, it was found that reflex movements of the eyeballs, accompanied by the feeling of dizziness, were not exhibited by 50 per cent. of them, while 49 out of 50 medical students examined in like manner exhibited these movements, the one who formed the exception exhibiting subnormal movements of the eyes. Kreidl came to the conclusion that the semicircular canals of the above-mentioned deaf-mutes, who did not experience any feeling of dizziness, must have been affected, and points out the remarkable conformity between the rate found and the frequency with which diseases of the semicircular canals were described by me as being present at post-mortem examinations of deaf-mutes. Further, it was proved that, while to 70 out of 71 medical students who were turned round rapidly in a large curve, upright objects looked oblique, to 20 per cent. of the deaf-mutes examined, the upright objects remained unchanged during the same motions. KREIDL was of opinion that these deaf-mutes retained the correct impression, because the otolith apparatus of the vestibule was destroyed, and therefore could not be influenced by the centrifugal force. Finally, KREIDL found that a great number of deaf-mutes were unable to walk straight with their eyes closed, or even to stand still upon one leg, and also that they exhibited great want of equilibrium under such circumstances. POLLAK endeavoured to produce giddiness in a number of deaf-mutes by conducting a galvanic current through their heads [218]. Several exhibited the signs of dizziness, accompanied by movements of the head and eyes also exhibited by normal subjects under like circumstances, while 29·3 per cent. were not affected in any way; in these then, it was to be supposed that the semicircular canals were entirely destroyed, and POLLAK points out the resemblance between the figures thus obtained and the percentage of cases of entire absence or destruction of the semicircular canals found by post-mortem examination of deaf-mutes.

OBJECTIVE EAR-SYMPTOMS.—*Discharge from the ear*, or *otorrhœa*, is the only objective ear-symptom I shall touch slightly upon, as its most frequent cause, suppuration of the tympanic cavity, will be treated of below. Most investigators have found that the majority of deaf-mutes suffer from otorrhœa, but that it is not so frequent a symptom as might be expected, considering how often acquired deafness is due to labyrinthine changes caused by suppurative inflammation of the middle ear.

SEQUELÆ.—Although deaf-mutism brings with it a long train of indirect consequences, which are of great importance as affecting the daily life of the deaf-mute, its more direct results are but few, and even these are the subject of dispute.

DEFICIENT DEVELOPMENT OF THE MENTAL FACULTIES.*—There can be no doubt that the want of such an important sense as hearing must at least result in a slow development of the mental faculties, as the pyschological function of the brain developes not only in proportion to its receptivity to impressions from without, which are so necessary for mental growth ("*nihil est in intellectu quod non antea fuerit in sensibus*"), and to the quality of these impressions, but also in proportion to their quantity, which must of necessity be diminished when one of the routes by which they reach the brain is closed, or partly closed. This does not of course prevent a deaf-mute from attaining the same degree of intellectual development as a normal person with the same amount of intelligence, if his physical deficiency is compensated for by such qualities as energy, industry, &c. There is, however, no doubt that purely practical considerations, for instance the necessarily limited choice of a profession, often hinder such a complete indemnification for the loss of so important a sense as hearing. The deaf-mute is thus deprived of one of the most important incentives to energy, namely, ambition; and it is, doubtless, in these external hindrances that the reasons are to be sought why no deaf-mute has as yet written his name in the pages of history. Further, the morbid processes causing deaf-mutism often have their seat in the brain, as has been already pointed out, and these processes often leave other traces behind them. HARTMANN found also [132, p. 14] that one-half of the pupils examined by him in deaf-and-dumb asylums, whose deafness was due to brain-disease, were but moderately or indifferently endowed with intelligence, and it was altogether doubtful whether many of these individuals were capable of instruction.* There are also statistical proofs from other countries that deaf-mutism is often accompanied by want of mental power. It is not, however, correct to infer that deaf-mutism can result in idiocy from the circumstance that deaf-mutes are often idiots. Idiocy, when it appears simultaneously with deaf-mutism, is the result of a congenital brain-disease, or one acquired in infancy, and is of superior or co-ordinate importance to the deaf-mutism itself; individuals exhibiting both these abnormalities must, doubtless, not be considered as idiotic deaf-mutes, but as deaf-and-dumb idiots (*see* below). H. SCHMALTZ [161, p. 108] and LEMCKE [171, p. 27 and 210, p. 115] have made some *measurements of the heads* of deaf-mutes in order to elucidate the question as to the intelligence possessed by deaf-mutes. Both these investigators found that the heads of deaf-mute children were, as a rule, smaller than the heads of normal children, especially in the younger periods of age. The reason is, doubtless, that the mental faculties of deaf-mute children are less developed than those of normal children.

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* I shall, in the following pages, pay but little attention to the mental peculiarities upon which so many authors lay stress as being characteristic of deaf-mutes, partly because their interest is mostly pedagogical, and partly because subjective opinions and theoretical considerations upon this subject are only too conspicuous with most authors. I will only mention here, what is often overlooked, viz., that the greatly emphasized good or bad moral qualities of deaf-mutes are often the result of good education in asylums or bad education in the homes, or of other mere external conditions.

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* Statistics have been drawn up in Italy as to the amount of intelligence possessed by deaf-mute children [176, p. 19]. According to these, 53 per cent. of the congenital deaf-mutes and 62 per cent. of those with acquired deafness in the asylums were intelligent, respectively 38 and 31 per cent. were moderately intelligent, and respectively 9 and 7 per cent. were deficient. This does not indicate any difference in the intellectual faculties of congenital deaf-mutes compared with those with acquired deafness.

DEFICIENT DEVELOPMENT OF THE LARYNX.—Earlier authors have laid considerable stress upon the condition of the larynx in deaf-mutes, indeed, some have gone so far as to suppose that deaf-mutism was caused by abnormalities of that organ (*see* below). L. V. SALOMONSEN has made a laryngoscopic examination of a number of deaf-mutes, without finding any important abnormalities [94], which result has since been confirmed by PRINZ [98]. The only anomaly of the larynx which is likely to be produced by deaf-mutism is a slight atrophy of the muscles, resulting from the complete mutism. It is, however, doubtful whether such a condition could be discovered by objective examination.

DEFICIENT DEVELOPMENT OF THE LUNGS.—MEISSNER declared that the lungs of deaf-mutes were, owing to mutism, as a rule, found on post-mortem examination, forced back in the cavity of the chest, &c., and that deaf-mutes consequently often died of consumption [74, p. 201]. MEISSNER'S first assertion has not been confirmed by later investigations, but the latter is in so far borne out, since tuberculosis of the lungs, as well as of other organs, has been found remarkably often at the post-mortem examination of deaf-mutes. Besides this, tuberculosis, which was formerly known under various names, was, according to earlier reports from deaf and dumb institutions, a frequent cause of death. Although it is not probable, as will be proved in the following pages, that the great frequency of consumption among deaf-mutes is due to deficient development of the lungs resulting from the mutism, still, on the other hand, it cannot be denied that the partial or entire inaction of the organs of speech may influence the function of the lungs. H. SCHMALTZ, who is one of our most conscientious investigators, has made a number of spirometric measurements and has found that the vital capacity of the lungs of deaf-mute children is generally less than that of normal children [161, p. 171]. He points out that this result may have something to do with the difficulty which is experienced in getting deaf-mute children to make the respiratory movements necessary for the investigations, as they are utterly unfamiliar with pulmonary gymnastics, and he is inclined to see in this circumstance the reason why children with acquired deafness exhibit greater vital capacity than children with congenital deafness, as the former have had opportunity to exercise their lungs before the appearance of the secondary mutism. My own experience convinces me that both deaf-mutes who have been taught to articulate, and those who have not been taught, have very little control over their respiration. This is evident from the speech of deaf-mutes who have been taught to articulate (*see* p 196), and also from the circumstance that the sound of the breathing of deaf-mutes heard through the stethoscope, or by placing the ear upon their chest, is, as a rule, much fainter than is the case with normal subjects. I have, on this account, often had greater difficulty in perceiving distinctly slight stethoscopic changes in the lungs of even robust deaf-mutes than in the lungs of persons in general. This want of control over the movements of the chest is perhaps not only due to the partial or total inactivity of the organs of speech, but also to the circumstance that deaf-mutes are unable to hear the sound of their own breathing, and are thus deprived of an important means of regulating their respiration. It is also a well-known fact that the oral or nasal respiration of deaf-mutes is much louder than that of persons in general.

OTHER SEQUELÆ.—Among these the following may be mentioned :

Tuberculosis.—The dependence of this disease upon a possible deficient development of the lungs of deaf-mutes has been touched upon above, where it was pointed out that tuberculosis, especially of the lungs, was found to be particularly frequent among children in deaf and dumb institutions. Nowhere has tuberculosis caused so high a mortality as in the Royal Deaf and Dumb Institution of Copenhagen in the first half of this century, and nowhere has its importance been more plainly proved, as a very considerable number of dissections were performed in this institution during a great number of years, which all, with but few exceptions, revealed tuberculosis as the cause of death [216]. Such was the spread of this disease among the children in the institution that in the years 1824–39 one-third of them died during their residence there [Malling-Hansen, 137, p. 29]. The cause of this spread of tuberculosis of the lungs in the Royal Deaf and Dumb Institution of Copenhagen is, however, easily explained by the following circumstances. When the new asylum, in 1839, replaced the older building, which had been devoid of the simplest sanitary arrangements, and was in other ways extremely unsatisfactory, the mortality among the pupils decreased rapidly, and in 1870 was even lower than among children in general of the same age.* This indicates that the great mortality from consumption, spoken of in earlier literature as existing in deaf and dumb asylums, was the result of bad sanitary conditions, and perhaps also of infection. This supposition is confirmed by more recent reports from deaf and dumb institutions, which do not mention consumption as prevalent among their inmates. It has not as yet been proved with any degree of certainty whether tuberculosis is especially frequent among adult deaf-mutes; it is, however, highly probable that this is the case. The most natural explanation is that deaf-mutes, as a rule, live under unfavourable social and sanitary conditions.

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*As the pupils at this institution are all taught by means of writing and dactytology, their excellent sanitary condition may perhaps be considered as an argument in favour of Baker's theory that the health of children who do not learn to articulate is no worse than that of children who do.

Scrofula.—HEDINGER [144, p. 125] and H. SCHMALTZ are of opinion that this disease is connected with deaf-mutism. Both authors found comparatively frequent signs of scrofula in deaf-mutes, but both consider this disease as the cause of deaf-mutism in the majority of cases in which they appeared simultaneously. LEMCKE found typical scrofula in no less than 16·7 per cent. of the deaf-mutes examined by him in Mecklenburgh-Schwerin [210, p. 165], and is also inclined to consider this disease as a cause of deaf-mutism. The connection between the two conditions has been already touched upon on p. 128, where it was pointed out that the great disposition of the organs of hearing to suppuration of the middle ear played, in all probability, the leading part in this respect. When it is remembered, however, that deaf-mute children as a rule live under unfavourable sanitary conditions, we shall perhaps feel inclined to look upon this circumstance as the principal cause of the frequency of scrofula among deaf-mutes.

Increased Mortality.—There are only two reliable statistical reports which elucidate the statement so frequently made, viz., that the mortality of deaf-mutes is considerably higher than that of normal individuals, both reports being from Denmark. The first concerns the mortality of deaf-mutes between the ages of 8–16, and has already been mentioned (*see* p. 206). The other includes adult deaf-mutes in Denmark in the years 1879–88 [200]. According to these latter statistics the mortality among adult male deaf-mutes during the years mentioned corresponded pretty exactly to the mortality among the labouring classes in Copenhagen, whose rate of mortality is the highest of any social class in Denmark. The mortality among adult female deaf-mutes was even greater than that among any other class of society. This high mortality among the deaf-mute population is, however, easily explained, since they, as a rule, live under unfavourable social and sanitary conditions, as was proved by various circumstances pointed out in the above-mentioned report.

Sterility.—All authors who have paid any attention to the question of the fertility of marriages between deaf-mutes [Lent, 101, p. 20, Wilhelmi, 108, p. 74, and Mygind, 200, p. 409] agree that such marriages result in comparatively few children (on an average 1·75–2·00 in each marriage). This apparent sterility is not, however, the direct result of deaf-mutism, but may—at least in Denmark—be explained by accidental circumstances which stand in a distant connection to that abnormality. Thus, it may be mentioned that marriages between deaf-mutes become more and more frequent, consequently, when statistics are drawn up, there will always be a comparatively large number of recent marriages in which but few children have been born.

Left-handedness.—Kilian found that a remarkably large number of deaf-mutes were left-handed [132,

p. 7]. HARTMANN, however, was unable to discover a single case among the deaf-mutes examined by him. The so-called "*mirror handwriting*" may be mentioned in connection with left-handedness. SOLTMANN found, on investigation, that a great number of deaf-mutes, especially those whose deafness was congenital or acquired in early infancy, made use of "mirror handwriting," by which is meant handwriting which resembles the reflection of ordinary handwriting in a mirror [183].

Diminution of Muscular Energy.—FERÉ and OUVRY state that deaf-mutes examined by them exhibited diminished energy and quickness in the movements of the muscles. In one case deficient movement of the muscles of the tongue was observed [211].

Extraordinary Development of other Senses.—It is natural to suppose that the deaf-mute would endeavour to compensate for his loss of hearing by an increased use of the other senses, especially *sight*, which would thus become more highly developed than is usual. ITARD, however, denies that deaf-mutes are in possession of better sight than normal individuals [30, p. 215], which opinion is shared by E. SCHMALZ [38, p. 27]. Numerous authors report cases in which deaf-mutes were able to perceive vibrations of sound by the aid of *touch*, which sounds normal persons were only able to perceive by the aid of hearing; other authors, again, quote instances of the rapidity with which deaf-mutes understood words written with a finger upon their skin [BURNET, 16, p. 248; HALLER, 20, p. 479; SENSE, 23, p. 17; ESCHKE, 25, p. 179; PFINGSTEN, 26, p. 17; HINZE, 35, p. 473; HILL, 70, p. 27; PUYBONNIEUX, 64, p. 75; KRUSE, 73, p. 30; and LUCÆ, *Arch. f. Ohrenh.*, vol. xiv., p. 133]. Many of the above-mentioned examples are of earlier date, and are not to be relied upon, which circumstance is of considerable importance since many of the cases reported border upon the incredible. A case observed by LUCÆ [*loc. cit.*] is one of the best established of an extraordinarily developed sense of touch. The deaf-mute in question was a seven-year-old boy of Jewish extraction, who, when blindfolded, was able to perceive familiar words (such as papa, Berlin, &c.) when these were uttered moderately loud against the palms of his hands, which were placed beside each other upon his back. E. SCHMALZ has also a case in which a blind deaf-mute girl, 11 years of age, had such extraordinary power of *smell* that she made use of it to distinguish persons, &c. [38, p. 114].

ABNORMALITIES FOUND BY OBJECTIVE EXAMINATION.—These refer principally to the ear, but also to other organs and parts of the body.

ABNORMALITIES OF THE EAR.—While the chapter on morbid anatomy was principally devoted to the pathological changes of the deeper parts of the ear, it is my intention in the following pages to give a description of the abnormalities found in those parts of the ear which are accessible to objective examination.

The External Ear.—It would naturally be supposed that as deaf-mutism is often caused by anomalies of the ear, deaf-mutes would often exhibit congenital abnormalities of the external ear. This is, however, not the case, as congenital malformations of the external ear are but seldom met with. A close investigation of the cases of malformation of the external ear reported in literature proves also that these abnormalities are but very rarely accompanied by such a diminution of the powers of hearing as to result in deaf-mutism, which circumstance has been laid much stress upon by Toynbee [86, p. 18]. The reason is perhaps that the external and internal ear develop independently of each other, and also that such malformations are generally one-sided. The malformations of the external ear of deaf-mutes mentioned in literature are as follows. Vanoni [50, p. 171] found the external ear represented by a shapeless mass of flesh, and the external meatus entirely invisible (this case was operated upon by Mazzoni and is identical with the one generally referred to that author). Schmalz examined a deaf-mute with considerable powers of hearing, whose one external ear was normal while the other was small and shapeless; the external meatus was wanting on either side [65, p. 2]. Bremer found the external ear replaced on either side by a longish irregular fold of skin containing cartilage; in this case also there was a considerable power of hearing and also absence of both external meatus [121, p. 17]. Hedinger reports a case in which the external ear was represented by a tap-shaped projection, and the meatus by a hollow [144, p. 62]. Lemcke mentions briefly some cases of the so-called cat-ear [171, p. 10 and 210, p. 175] and also of enlarged or dwarfed ear (*macrotia* and *microtia*) of which Bremer has also examples [135, p. 102].

The external Auditory Meatus.—Other abnormalities of the external meatus, besides those mentioned above, have been frequently observed. It is, however, often difficult to decide the nature of the abnormalities from the descriptions of them we possess, and a comparison of the frequency with which they have been found by various investigators is therefore of no interest. Contraction of the meatus would seem to be the abnormality most frequently met with. The greatest interest, however, attaches to the closing of this passage, which has been found by many investigators unaccompanied by any malformation of the external ear. There can be little doubt that when the meatus is closed by a membrane situated close to the external ear, this is due to congenital malformation; should the membrane, however, be situated in the neighbourhood of the tympanum, it is possible that the obstruction is the result of an inflammation of the tympanic cavity. I have, at least, in two cases, observed such a closing of the external meatus of deaf-mutes resulting from scarlatinal inflammation, in the one case on both sides, in the other on one side.

The Drumhead.—As abnormalities of the tympanic cavity, resulting from existing or old morbid processes in that part of the auditory organ, can be detected by means of an examination of the drumhead, it is remarkable that otoscopic examinations of deaf-mutes have contributed very little to the pathogenesis or etiology of deaf-mutism. Such examinations have been published by various authors, among whom may be mentioned Toynbee, Roosa and Beard, Bremer, Hedinger, H. Schmaltz, Chr. Lemcke, Jacquemart

[153], Uchermann, Bull [178], Roller [174], Bliss [204], and Grazzi [213]. These investigations, in spite of the care which has been bestowed upon them, have led to very little result, indeed the various authors differ considerably in the results obtained. The reason of this discrepancy is, doubtless, that the causes of deaf-mutism vary in intensity at different times and in different places. Thus the frequency with which extensive destructions of the walls of the tympanic cavity resulting from inflammation of that cavity is found, will depend upon the part which scarlet fever has played as a cause of deaf-mutism in the cases examined. The age of the individuals examined is also doubtless of importance, partly because existing catarrhal processes of the tympanic cavity are more distinctly traceable in the drumhead the more remote their origin, and partly because past destructive processes become more faintly marked as time goes on, since the regenerative power of the drumhead is very considerable. Finally, the boundary between a normal and a morbidly changed membrana tympani is very indistinct, and consequently an opinion upon this subject must often depend upon personal judgment. This is also in all probability the reason why the results arrived at by various investigators differ so greatly as to the frequency with which the drumhead of deaf-mutes is found of normal appearance. Roosa and Beard represent the one extreme, having found that only one-third of the deaf-mutes examined by them exhibited normal drumheads, while H. Schmaltz found that in more than one-half of the cases examined by him the otoscopic examination yielded negative results, and in 13 per cent. the morbid changes were

of doubtful importance [161, p. 165]. In some points, however, the investigations agree; of these, the following are worthy of mention: To begin with, the anomalies found in the drumheads of deaf-mutes were frequently but slightly pronounced, and consequently had in all probability but little influence upon the deafness, a circumstance which has already been pointed out by TOYNBEE [86, p. 396], "in the majority of the ears there was some abnormal appearance, although it was often very slight." Further, the abnormalities found were in no wise especially characteristic of deaf-mutism, but were the same as observed on investigation of the ears of a number of normal subjects, especially children. This latter circumstance is particularly interesting, as the majority of deaf-mutes examined were children. The difference, then, in the results of examinations of normal children and pupils at deaf and dumb asylums lies in the greater frequency with which the abnormalities found appeared in the deaf-mutes, and not in the nature and kind of these abnormalities. It may also be mentioned that the anomalies of the drumheads of deaf-mutes were generally the expression of two principal groups of morbid changes, either existing or past, viz., catarrhal and suppurative inflammations of the tympanic cavity, which fact accords well with the results yielded by post-mortem examinations of deaf-mutes (*see* chapter II.). Finally, all investigators who have classified the deaf-mutes examined by them according to the origin of their deafness (congenital, acquired or doubtful), agree that the otoscopic examination of the drumheads in cases of congenital deafness yields a negative result more frequently than in cases of acquired deafness, the latter more frequently exhibiting destructive inflammatory processes or traces of such. This latter circumstance is not surprising, since deaf-mutism resulting from acquired deafness is frequently due to diseases which produce suppurative inflammation of the tympanic cavity, which must moreover be considered to be the *primary* cause of the ear trouble causing deafness. There is much more reason to wonder that traces of existing or extinct suppuration of the middle ear are not found more frequently than they are; especially remarkable is the circumstance that in a comparatively large number of cases of deafness from scarlatina and measles no abnormality has been found in the parts of the middle ear which are accessible to examination. I have gone into this more explicitly in the foregoing chapter, where I used this fact as a proof that the appearance of deafness is not dependent upon the intensity of the suppuration of the middle ear, and I also pointed out that the abovementioned circumstance seems also to indicate that disease of the middle ear is not absolutely necessary as an intermediate link. The otoscopic examination of deaf-mutes thus yields results which coincide perfectly with those yielded by post-mortem examinations of deaf-mutes, viz., that abnormalities of the middle ear are frequent in deaf-mutes. The cause of deafness, however, was, according to the post-mortem investigations principally due, in the majority of cases, to labyrinthine changes, and not to abnormalities of the middle ear. What, then, is the importance to be attached to these abnormalities in the middle ear found by post-mortem as well as by otoscopic examination? A satisfactory answer is at present scarcely forthcoming, as the following possibilities exist. The affections of the middle ear may be accidental abnormalities. In support of this it may be mentioned that a perfectly normal drumhead is not an absolute requisite to normal hearing, since individuals with normal power of hearing may exhibit even marked anomalies of the drumhead, and more pronounced anomalies still, such as perforation, calcareous deposits, &c., may be the result of ear troubles subsequent to the appearance of deafness. The circumstance that the ears of deaf-mutes are more vulnerable than those of normal persons (*see* p. 137) indicates that this latter hypothesis is correct, and it may also be observed that BREMER and UCHERMANN found foreign bodies in the ears of deaf-mutes with remarkable frequency. Further, it is possible that the disease in the middle ear appears in some cases simultaneously with the labyrinthine affection. This might, for instance, be suggested in cases where inflammation is propagated from the membranes of the brain, and attacks the labyrinth and middle ear simultaneously. It is also possible that the diseases of the middle ear so frequently found in deaf-mutes indicate that this part of the organ of hearing was that first attacked. This explanation is doubtless correct in a number of cases of acquired deafness, in which there are symptoms of existing or extinct *suppurative* processes, and where the origin of the deafness can be traced to diseases which are known to have a tendency to complication with otitis media. We are not, however, justified in such cases in considering the affection of the middle ear as the *principal* cause of deafness, partly because post-mortem investigations prove that it is quite the exception for disease of the middle ear to form the sole cause of deafness in deaf-mutes, and partly because pronounced changes of the labyrinth have been found when one of the above-mentioned diseases have given rise to the deafness. The *catarrhal* changes of the middle ear in deaf-mutes, especially congenital deaf-mutes, so frequently discovered by otoscopic examinations, are of a more doubtful nature. Beard and Roosa are especially very decided in supposing these changes, together with the anomalies of the mucous membranes of the adjacent cavities (naso-pharynx, nose, &c.), which are so frequently met with in deaf-mutes, to be a proof that congenital deafness is often due to a fœtal inflammation of the middle ear [96], which opinion seems to be shared by several American otologists [165, p. 471, and following]. I have gone very minutely into the question of the importance of inflammation of the middle ear in the genesis of congenital deaf-mutism [189], making use of especially reliable material from Dr. Wilhelm Meyer's clinic, and shall not, therefore, say more in this place than that many circumstances seem to indicate the importance of this mode of origin in congenital cases, though not to the extent claimed for it by Beard and Roosa. These circumstances are the following: (1) that catarrhal conditions are frequently found in deaf-mutes in the middle ear and the adjacent mucous membranes; (2) that some few post-mortem examinations have proved changes in the middle ear alone to be the cause of deaf-mutism; (3) that congenital deaf-mutism sometimes improves with time, and finally, (4) that deaf-mutes with congenital deafness comparatively frequently possess a certain power of hearing.

The Eustachian Tube.—BREMER performed catherisation of the Eustachian tubes in a large number of deaf-mutes, and found them normal in the majority of cases [135, p. 105]. ROLLER, however, found in 63 out of 73 cases, contraction or closing of these tubes [174, p. 42]. LEMCKE, who made use of bougies in his examinations, found pronounced stenosis in 98 cases out of 380, and three times as frequently in acquired cases as in congenital [210, p. 205].

The Mastoid Process.—No important changes of this region have been found by any investigators who have examined a large number of deaf-mutes.

ABNORMALITIES OF THE MUCOUS MEMBRANES ADJACENT TO THE EAR.—Catarrhal changes of the mucous membranes of the nose, naso-pharynx, and pharynx, have been frequently observed by investigators (*see* the authors, with the exception of TOYNBEE, mentioned p. 212). These changes have most frequently taken the form of hypertrophy of the whole mucous membrane, or of the adenoid tissue (adenoid vegetations, hypertrophy and hyperplasia of the tonsils), less frequently the form of atrophy (ozœna, atrophic catarrh of the naso-pharynx and pharynx). The frequency with which catarrhal changes of the upper air tract has been observed by investigators varies greatly. Thus, ROOSA and BEARD found that no less than 67 per cent. of the deaf-mutes examined by them suffered from chronic catarrh of the pharynx, or chronic inflammation of the tonsils [96], while H. SCHMALTZ only found such affections in 13 per cent. of the cases examined by him [161,

p. 167]. Bliss found adenoid vegetations in 17 per cent. of the deaf-mutes he examined [204], E. Schmalz, on the other hand, in hardly 2 per cent. Other affections of the mucous membranes of the nose, &c., have been also observed with varying frequency by various investigators. A comparison of the results obtained is, however, impossible, owing to the different ways in which each has classified his cases. The various investigators disagree also as to whether affections of the mucous membranes of the upper air passages are more common among congenital deaf-mutes or deaf-mutes with acquired deafness. One author even (Hedinger), has found nasal affections more common among congenital deaf-mutes, while diseases of the throat were most frequent among deaf-mutes with acquired deafness [144, p. 120]. The cause of these discrepancies is doubtless to be sought in the circumstances mentioned p. 213, also in the fact that catarrhal diseases of the nose, naso-pharynx, and pharynx, appear with varying frequency in different countries and in different classes of society, as climate, mode of living, clothing, hygienic conditions, &c., as is well known, play an important part in the appearance of catarrh of the air-passages. The results of such examinations of deaf-mutes will, therefore, first be of use in judging of the relation of such affections to deaf-mutism, when we possess information as to the frequency with which catarrhal diseases of the upper air-passages appear in normal subjects of the same age and living under the same conditions as the deaf-mutes, with which we can draw comparisons. An investigation of this nature has been made in Denmark so far as congenital deaf-mutes are concerned [189, p. 78]. The results obtained generally tended to prove that catarrhal affections of the mucous membranes adjacent to the ear are not more frequent in deaf-mute children than in ordinary school children. We are not, however, justified in concluding that catarrhal diseases of the nose, naso-pharynx, and pharynx, are of no importance in congenital deafness, and still less in deafness acquired in childhood, since it is probable that the catarrhal affections observed in deaf-mutes, are in many cases closely connected with the ear-disease causing deafness, for it is possible that the catarrhally-affected mucous membranes of the nose, naso-pharynx, and pharynx, have an especial tendency to play the part of inlets for the morbid processes which cause inflammation of the middle ear resulting in deaf-mutism, and which appear in certain epidemic diseases (scarlet fever, measles, &c.), or it is also possible that catarrh in these parts is immediately propagated into the ear, and thus produces the ear-disease causing deaf-mutism. This latter hypothesis has been especially upheld by Beard and Roosa, and certain post-mortem examinations, and other previously-mentioned circumstances, tend to prove that deafness acquired in infancy may originate in this manner. Future investigations will doubtless determine whether this mode of origin is the exception, or whether it is of greater importance. It must, finally, be mentioned that Boucheron is of opinion that catarrh of the mucous membranes adjacent to the ear plays yet another part in acquired deaf-mutism, viz., by causing the so-called *otopiesis*. Under this term, Boucheron [172, p. 26] describes the mechanism which causes deafness by producing exhaustion of air in the middle ear as the result of the closing of the catarrhally-affected Eustachian tube, which process, again, causes overpressure in the inner ear, and, consequently, degeneration of the terminations of the auditory nerve. This interesting theory rests, however, at present, on a very slight physiological and clinical foundation.

ABNORMALITIES OF THE CRANIUM.—Abnormalities which sometimes appear in the skulls of deaf-mutes have not received the attention which they perhaps deserve, and literature contains only a few scattered reports upon this subject. Pronounced asymmetry of the cranium is mentioned by various authors in their reports of post-mortem examinations. Besides these, literature contains some scattered accounts of cases of asymmetry and other congenital malformations of the cranium. HEDINGER [144, p. 47] found, out of 415 deaf-mute children, three with remarkably large heads (macrocephalus and hydrocephalus), two with small heads (microcephalus), and four with pointed heads (oxycephalus). It may be mentioned, further, that LENT, who made a digest of the reports of 303 deaf-mutes in the district of Cologne, found that no less than six of them were stated to have abnormally large heads, while there were only two whose heads were abnormally small [101, p. 19]. There is no doubt that the abnormalities of the cranium occasionally observed in deaf-mutes are in most cases the result of a brain-disease, either congenital or acquired in infancy, which has caused an arrest of the development of the brain in size, or has caused an increase in the size of the brain through hypertrophy of the tissue, or through the development of hydrocephalus. There is, therefore, reason to expect that the majority of deaf-mutes with abnormalities of the skull will exhibit deficiency of mental power, and in many cases idiocy with its accompanying symptoms. Besides the anomalies of the skull briefly mentioned above, deaf-mutes often show a slight diminution of the dimensions of the skull; this anomaly and its cause has been already mentioned p. 203.

ABNORMALITIES OF THE EYE.—Although we find several notices of abnormalities of the eyes of deaf-mutes in earlier literature, it is only quite latterly that any attempts have been made to explain the connection between deaf-mutism and certain abnormalities of the eye. LIEBREICH was the first to define precisely the connection between deaf-mutism and *retinitis pigmentosa.* Retinitis pigmentosa, which appears both as a congenital disease and particularly as a disease acquired in infancy, is, as is well known, recognisable in its more pronounced forms by the patient having difficulty in seeing in the twilight or in artificial light *(hemeralopia)*, while the sight in daylight is comparatively good. Further, the patient's field of vision is often very limited, so that he can only see objects placed immediately in front of him ("hen-blindness"). This latter condition may be so pronounced that the individual in question is unable to guide himself in full daylight although he is able to read the smallest handwriting. This eye-disease exhibits itself objectively by certain changes in the retina, among which deposits of pigment are particularly characteristic. While the congenital disease generally takes the form of hemeralopia, and, as a rule, remains at a standstill as long as the patient lives, limitation of the field of vision is more pronounced in acquired cases, and is generally of a progressive nature, often resulting in complete blindness. LIEBREICH examined 241 deaf-mutes with the opthalmoscope, and found no less than 14 with retinitis pigmentosa [87, p. 54], *i.e.*, 5·8 per cent., which frequency is very considerable when we remember how rare this disease is. LIEBREICH proved further that retinitis pigmentosa is hereditary in certain families, either together with, or alternating with, deaf-mutism, and it was also particularly frequent among children born in consanguineous marriages. This disease was, according to LIEBREICH, particularly frequent among Hebrews, eight of the individuals examined by him belonging to that race. More recent investigations show a lesser frequency of retinitis pigmentosa among deaf-mutes, the rates varying from 0 [COHN, 191, p. 15] to 5·2 [SCHÄFER, 163, p. 65].* Finally, LENT, in his digest of the reports of deaf-mutes in the district of Cologne, states that six exhibited undeniable symptoms of retinitis pigmentosa; of these, three were congenital deaf-mutes and three deaf-mutes with acquired deafness [101, p. 18], while LEMCKE never observed this disease in cases of congenital deaf-mutism, but did so in three cases of acquired mutism [210, p. 164].

It is to be expected that deaf-mutes exhibit congenital malformations of the eyes with some frequency, as well as of other organs and parts of the body, for instance, anophthalmus, colomba, &c.; there are, however, only a few reports of such cases. It might also be supposed that certain eye-diseases, which are known to be caused by several of the diseases resulting in deaf-mutism, would be frequently met with in deaf-mutes. Epidemic cerebro-spinal meningitis in particular often causes different diseases of the eye, which have one thing in common, viz., that they are very injurious to the sight, partly because they destroy the refracting parts of the eye, especially the more deeply seated, and partly, and probably most frequently, because the optic nerve and its ramifications in the eye are the seat of the disease. Acute exanthematic diseases, especially small-pox and scarlet fever, produce inflammatory processes in the eye, which sometimes even destroy the whole visual organ *(panopthalmia).* We have, however, no information as to the frequency of these eye-diseases and their sequelæ which are so closely related to the causes of deaf-mutism in the cases in question. Finally, it would seem probable that *keratitis interstitialis* s. *parenchymatosa*, which appears together with deafness in cases of inherited syphilis, would now and then be exhibited by deaf-mutes. It is, however, doubtless difficult in many cases to decide whether the abnormalities of the eyes are connected with the deaf-mutism, or are only accidental phenomena, for instance, *maculæ corneæ* resulting from scrofulous keratitis, and *squint*, which is often met with in deaf-mutes. In some respects, however, the eyes of deaf-mutes seem to be better than those of normal individuals. ADLER, SCHÄFER and COHN found that short-sightedness *(myopia)* was comparatively rare among the pupils examined by them respectively in the deaf and dumb asylums in Vienna, Gerlachsheim and Breslau, and that the shortsightedness was not considerable, neither did it increase in the older classes as is the case in schools in general [respectively 117, 163 and 191]. COHN believes that the explanation of this is to be sought in the circumstance, that the deaf-mute children examined worked in an excellent light, and that their sight was not so much tried with reading as is the case with normal children, while ADLER and SCHÄFER give other explanations of this condition.

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* The reason of this discrepancy is, perhaps, that there were a comparatively large number of Hebrews among the deaf-mutes examined by LIEBREICH Berlin.

The circumstance which has been touched upon in the above, that deaf-mutism and certain congenital and, in infancy, acquired eye-diseases, have a common origin, explains *the co-existence of deaf-mutism and blindness*, which has so often been found by statistical investigations, either alone or accompanied by idiocy. The more modern statistics as to the frequency of co-existent deaf-mutism and blindness differ very little in their results, all agreeing that about half per cent. of deaf-mutes are also blind, or blind and feebleminded [census in Denmark, Prussia, Sweden and the United States, respectively 154, p. cxvi.; 157, p. 224; 163, p. xliv.; and 180, p. xxxviii.]

ABNORMALITIES OF THE ORGANS OF SPEECH.—It has already been mentioned, p. 203, that erroneous opinions as to the importance of the larynx and other organs of speech in deaf-mutism, gave rise to erroneous ideas as to the deficient development of these organs in deaf-mutes. Theories based upon incorrect premises have also caused many earlier authors to describe various abnormalities in the larynx and the other organs of speech of deaf-mutes. That many authors have described abnormalities of the tonsils, the uvula and the palate, is but natural, as these parts are often abnormally altered in deaf-mutes (*see* above). On the other hand, pre-conceived opinions and insufficient investigations are certainly the cause of numerous reports of remarkable abnormalities of the larynx, among these, that published by GIBBS may be mentioned, in which the vocal cords were said to have been absent ("Medical Times and Gazette," 1862). As mentioned before, L. V. SALOMONSEN made investigations with the aid of the laryngoscope, and discovered nothing abnormal in the larynx of the deaf-mutes examined [94], which result has since been confirmed by PRINZ [98], who, however, found a slight catarrh of the vocal cords in the majority of the deaf and dumb children examined by him, which catarrh he is inclined to ascribe to the exertions made in learning to speak. LEMCKE mentions that the majority of deaf-mute children examined by him, exhibited a remarkably developed larynx, and also on laryngoscopical examination, a pronounced catarrh of the mucous membrane [171, p. 26]. LEMCKE is inclined to see a connection between this circumstance and the catarrh of the pharynx, nasopharynx and nose which he frequently observed. LEMCKE also observed atrophy of the vocal cords in some few older deaf-mutes, especially such as had never learned to articulate. The results arrived at by BLISS from examinations of the throats of 415 deaf-mutes point in the same direction, the vocal cords being frequently of a greyish colour and remarkably narrow and thin [204].

ABNORMALITIES OF THE THYROID GLAND.—Swelling of the thyroid gland (*goitre*, *struma*) has been observed with remarkable frequency by BIRCHER, in Swiss deaf and dumb institutions, 64 per cent. of the pupils with "sporadic deaf-mutism," and 77 per cent. with "endemic deaf-mutism," exhibiting this abnormality; while it was only the case in 32 per cent. of normal school children [158, p. 182]. I have, however, already pointed out that the deaf-mutism which is prevalent in Switzerland seems in many cases to differ from that which is treated of in the present work, and goitre is nowhere so frequent among deaf-mutes as is the case in Switzerland. Thus HEDINGER found only six, *i.e.*, 4 per cent. of the 181 congenital mutes in the deaf and dumb institutions of Baden and Würtemburg with cretinism, or a disposition to it [144, p. 65, and following]; he does not, however, state what the symptoms of cretinism were; neither does he inform us whether the individuals in question suffered from goitre. In the district of Cologne only 2 per cent. of the deaf-mutes suffered from "struma in a slight degree" [LENT, 101, p. 17]. In the district of Madgeburg, which includes some mountainous districts where goitre is endemic, WILHELMI could only discover this abnormality in six out of 284 congenital deaf-mutes, *i.e.*, in 2 per cent. [108, p. 74], and he therefore concludes that the complication of deaf-mutism with goitre is purely accidental, and in no way of causal importance. In Mecklenburg-Schwerin LEMCKE observed nine cases of goitre among 533 deaf-mutes. In Denmark none of the 553 deaf-mutes are reported as suffering from goitre in the forms mentioned p. 45.

It must, however be observed that goitre is seldom met with in Denmark, and that the forms contain no space for this abnormality.

PARALYSIS AND PARESIS OF THE MOTOR NERVES.—Both these abnormalities seem to be more frequent among deaf-mutes than among individuals in general. The most frequent form is paralysis of the facial nerve, which is often unilateral, and is manifested by a relaxation and immovability of the one-half of the face. The paralysis of the facial nerve of deaf-mutes is doubtless due to the circumstance that this nerve is topographically closely connected with the ear in a considerable part of its course; we have, however, no immediate information upon this subject. As post-natal ear-diseases causing deaf-mutism are more destructive than fœtal diseases of this kind (*see* Chap. III.), it would seem probable that paralysis of the facial nerve would be particularly frequent among deaf-mutes with acquired deafness. This proves also to be case by a closer observation of HEDINGER's investigations, according to which only two out of nine cases of paralysis of the facial nerve occurred in congenital deaf-mutes [144, p. 57 and following], and while this paralysis appeared in 3 per cent. of the pupils with acquired, it appeared in only 1 per cent. of those with congenital deafness. On the other hand paralysis in *general* appeared four times as frequently in congenital deaf-mutes as in those with acquired deafness. WILHELMI found paralysis in general much more frequent among mutes with acquired deafness than among congenital mutes, both in Magdeburg [108, p. 74 and 78] and in

Pommerania-Erfurt [134], and in both places the difference was very considerable. LEMCKE's investigations in Mecklenburgh-Schwerin have corroborated WILHELMI's results [210, p. 164], and in this province 2 per cent. of all the deaf-mutes suffered from some paralysis or other, while LENT found 3 per cent. of the deaf-mutes in Cologne with paralysis [101, p. 17]. This very considerable frequency of paralysis among deaf-mutes is doubtless connected with the above-mentioned relationship between deaf-mutism and acquired and congenital brain-diseases. Besides the face, the extremities of deaf-mutes are often paralysed, and this paralysis may be either unilateral (*hemiplegia*), or bilateral (*paraplegia*). WILHELMI mentions a case of paralysis of the back; a similar one was reported in Denmark, in the case of a woman born in 1857, whose paralysis was so complete that she was unable to keep the vertebral column upright; the cause was stated to be a disease, the symptoms of which indicated that it was cerebro-spinal meningitis. Only four of the 553 deaf-mutes in Denmark were reported as suffering from circumscribed paralysis. Idiots are not, however, included in these reports, which circumstance is doubtless of importance, as it is a well known fact that idiots are often more or less paralysed. Finally, it may be observed that the *squint* so often observed in deaf-mutes may be the result of a paralysis of the muscles of the eye. As this abnormality, however, may be caused by certain eye-diseases, such as keratitis, anomalies of refraction, &c., which have nothing to do with deaf-mutism, and as no notice has been taken of its cause in the majority of investigations embracing a large number of deaf-mutes, I shall not go more particularly into this subject in these pages.*

MALFORMATIONS.—Besides the malformations of the auricle mentioned above, arrest of development has been also observed. Of these the principal are hare-lip *(labium leporinum)* cleft palate *(palatum fissum)*, fissure of the breast-bone *(fissura sternalis)*, webbed fingers and toes *(syndactylia)*, &c., &c. Such malformations have been observed most frequently in congenital deaf-mutes, whose deafness in such cases has doubtless been due to malformations of the inner ear. HEDINGER states the frequency with which malformations appeared in the children examined by him to be about 2 per cent. [144, p. 114], while the corresponding figure in the district of Magdeburg was 1·5 [WILHELMI, 108, p. 77]. Malformations are mentioned with a corresponding frequency in the reports of congenital mutes in Denmark, mentioned in p. 45, there being four with such abnormalities among the 226 congenital mutes in that country (cleft palate, deformed throat and tongue, deformed hand and foot, and congenital luxation of the hip).

COMPLICATION WITH IDIOCY.—The circumstance, which has been frequently pointed out, that the remote and immediate causes of deaf-mutism and idiocy to a certain extent are the same, which is seen for instance by the two conditions appearing alternately in the same family, easily explains the frequent complication of deaf-mutism with idiocy. There is but little in literature which tends to show which form of deaf-mutism appears most frequently to be accompanied by idiocy. E. SCHMALZ is of opinion that idiocy is most common in deaf-mutes with acquired deafness, but does not give his reasons for this supposition. In Mecklenburg-Schwerin, LEMCKE found altogether 22 cases of deaf-mutism and idiocy (imbecility). All these cases occurred in mutes with acquired deafness [210, p. 164]. The investigations made in Denmark, mentioned p. 45, throw no light upon this question, as they do not include idiotic deaf-mutes. The frequency with which deaf-mutism is reported as being complicated with idiocy varies greatly, the two extremes being represented by the North American statistics of 1880 and the Danish statistics of the same year. According to the former, no less than 3,339 out of 33,878 deaf-mutes were also idiotic, or idiotic and blind, *i.e.*, about 10 per cent. [180, p. xxxvii.]. According to the latter, there were only 17 such individuals among 1,243 deaf-mutes, *i.e.*, 1·3 per cent. [154, p. cxvii.]. The reason of this discrepancy is doubtless that the boundary lines which determine idiocy are not at all hard and fast, as will be seen from the number of terms used to describe this condition (idiocy, imbecility, feeble-mindedness, deficiency of intellectual power, &c.). In Denmark, where, as we have just seen, the least number of idiotic deaf-mutes were found, 10 per cent. of the pupils admitted into the asylums in the years 1871–78 were described as "feeble-minded" [182, p. 16], which term was afterwards replaced by "of deficient intellectual power" [113, p. 24]. It must, however, be once more emphasized that the considerable frequency with which idiocy appears, together with deaf-mutism, is no proof that deaf-mutism frequently causes idiocy, but is simply an expression of the circumstance, that the same causes which lead to deaf-mutism may produce such an effect upon the construction and development of the brain as to result in idiocy. Further, I would lay stress upon the following, viz.: that in cases where deaf-mutism is complicated with idiocy, it is the idiocy which is the principal pathological condition, and that such individuals should be described as deaf-mute idiots. The majority of hitherto published post-mortem examinations of deaf-mutes who were also idiotic, prove that pronounced morbid changes existed in the brain, and but slight abnormalities in the ears.

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* In the deaf and dumb institution at Breslau, COHN found six of the 286 pupils with squint; in all these cases it was owing to abnormalities in the refracting media of the eye [191, p. 14].

COMPLICATION WITH INSANITY.—The frequency of this complication has been especially pointed out by Wines, who based his opinion upon the comprehensive statistics from the United States. He comes to the conclusion, that deaf-mutes have four times as great a disposition to insanity, as individuals in general [180, p. xxxix.]. This circumstance Wines explains as being the result of the deaf-mute's isolated social position, and of the mental depression which deaf-mutism naturally brings in its train, just as the blind from the same causes are also more exposed to insanity than normal subjects, and even than deaf-mutes, their disposition to insanity being six times as great as individuals with normal sight and hearing.

CHAPTER IV.

DIAGNOSIS, PROGNOSIS, AND TREATMENT.

DIAGNOSIS.—Although deaf-mutism from a theoretical point of view is not a very distinctly defined condition, still the majority of cases are, as a rule, easily recognised. The question whether an individual is a deaf-mute or not, must, according to what has been laid down in the foregoing pages, be principally decided by examinations as to the function of the auditory nerve. If this is entirely suspended, or so reduced that speech cannot be heard, and if the history of the case proves that this condition dates from birth or infancy, then the individual must be considered to be a deaf-mute. We are also justified in applying this term, as has already been pointed out, even when there exists some power of speech either acquired by special means of instruction or, when the deaf-mutism has appeared at a more advanced age, retained to a greater or less extent. The circumstance that the pathological condition called deaf-mutism is based upon a symptom, the extent of which cannot be measured with any degree of certainty, but which nevertheless is decisive, naturally causes arbitrary decisions in some cases, which decisions generally depend upon purely practical considerations [*see* p. 2 and 194]. In other words, there are persons as to whom it is difficult to say with certainty whether they are deaf-mutes or not. Such are persons who can hear the human voice to a certain extent, and who consequently learn to articulate by the aid of special methods of instruction,* or such as have lost the power of hearing so late that they have retained the power of speech, although their voice is always somewhat peculiar. Such individuals are, however, but few in number, and consequently the difficulty in diagnosing deaf-mutism mentioned here is of very slight practical importance.

Of much greater importance are the difficulties which present themselves when the individual in question is an infant. It must, however, be pointed out that the term deaf-mute is incorrect when applied to children under one year old, as no children can speak at that age. It would seem indeed that great caution must be observed in drawing the conclusion that deaf-mutism will necessarily be the result of even total deafness observed during the first year of infancy, since, according to HARTMANN, there are some children who are unable to react, or who react very slowly to sounds during the first year of infancy, but whose hearing, nevertheless, when older, is perfectly normal [132, p. 19]. In any case it is extremely difficult to arrive at any decided opinion whether an infant possesses the power of hearing or not, and especially as to what degree of hearing it possesses, and, as a rule, the younger the child the greater is this difficulty. The reason is doubtless that the sound-conducting apparatus of infants is not complete at birth. The external meatus and the tympanic cavity are transformed after birth from cavities filled with cellular tissue to pneumatic cavities. It was formerly supposed that infants did not react to sound, but SACHS has quite recently proved that this is not the case, even with newborn infants, and also that infants can perceive musical notes [220]. Even in the second half of the first year of childhood it is, however, as above mentioned, very difficult to decide whether the power of hearing exists or not. No great confidence can be attached to the statements of a child's friends as to its having heard certain sounds, as it has been proved that the vibrations of the air caused by certain sources of sound, may produce effects upon the sensory nerve which may be mistaken for the result of vibrations of air acting upon the auditory nerve. It is, therefore, of the greatest importance in experimenting with the hearing of infants to make use of such sources of sound, or to make use of them in such a manner, that only the vibrations of sound produced can be perceived. Loud dinner-bells are suitable for this purpose, also the so-called watchman's whistle, clapping of hands, and the firing of small pistols, which the child should not be allowed to see. If the child reacts to these sounds it will blink its eyes, or exhibit joy or fear.

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* In Denmark, according to a regulation printed in the report forms for "not previously reported deaf-mutes," all children are considered as deaf-mutes "who cannot be instructed in the same way as normal children, on account of congenital or acquired deafness, or imperfect hearing (whether totally dumb, with some slight power of speech, or with the entire power of speech)." All such children are to be reported on the forms especially used for deaf-mutes, and are sent, after completing their eighth year, to the government institutions for the deaf and dumb. This practical definition is so clear that it seems worthy of universal adoption.

Should the results of such experiments be negative, it is not necessary, as above mentioned, to conclude that the child will become a deaf-mute. After the completion of the first year of infancy, however, the older the child the greater the importance which must be attached to such negative results. After that period, however, we may look for another symptom to help us in our diagnosis, viz., the absence of speech. This, too, may be delusive, as some children, although in full possession of normal powers of hearing and intellect, do not begin to speak at the end of their first year, but later—sometimes even much later. The cause may be some hidden condition or constitutional disease, for instance rickets.

Another condition which may be mistaken for deaf-mutism is simple mutism (*aphasia*), uncomplicated with deafness or idiocy. This abnormality, which is not at all rare in adults as the result of certain brain-diseases, is but seldom congenital or acquired in infancy, at least there are but few references to it in literature [WILDE, 72, p. 465 and following; BROADBENT, 106, p. 155; WALDENBURG, 109, p. 8; UCHERMANN, 194, p. 313 and following]. According to these authors, this form of aphasia must be considered to be the result of a disease which is localised in the central nervous system, causing total inability of speech in the individual affected, or inability to speak more than a few indistinct words. This infantile aphasia, which seems to be as a rule congenital, differs from the mutism of deaf-mutism, principally in as much as it is not accompanied by deafness, and often also in the individual affected being able to produce certain words or sounds resembling words, which are always employed in attempts at speech. Aphasia accompanying feeble-mindedness, imbecility, or idiocy, is a much more frequent abnormality, which is still more easily mistaken for deaf-mutism, especially in such cases where the imbecility is so considerable, that the interest for sound is diminished. In these cases, however, the imbecility which must be considered as the primary disease, will generally show itself in the patient's appearance, movements, gestures, &c.

Finally, *simulation of deaf-mutism* deserves a brief notice, as there is one case on record of this kind. It was that of a lad who played the part of a deaf-mute so well, that he deceived his friends for a considerable length of time [Venus, 84]. When we remember the patience and cunning which many malingerers display, and the great difficulty which even specialists experience in detecting them, it is not to be wondered at that deaf-mutism, the symptoms of which are of a more negative kind, may be simulated. It has been supposed that persons simulating deaf-mutism would be most easily detected by placing them with real deaf-mutes, among whom they would feel perfectly strange. Further, the suggestion has been made that sounds produced by tapping the floor, by striking a tuning-fork, which should then touch the skin, would be ignored by the malingerer, while the deaf-mute would perceive them by the aid of touch. The most reliable mode of detection in such cases, would be doubtless to chloroform the suspected person, and to ascertain whether the power of hearing and speech existed either during the period of excitation, or while the patient begins to recover from the narcosis.

A similar treatment is to be recommended in doubtful cases of *hysterical-mutism*, which is generally accompanied by pronounced symptoms of hysteria, and which exhibits itself by the patient making no attempt to speak, or even to articulate. It is generally of short duration and is easily recognised, the diagnosis only offering some difficulty in cases where the mutism appears in deaf hysterical subjects.

The question whether deaf-mutism is congenital or acquired, is doubtless that which offers the greatest difficulty in forming a diagnosis of deaf-mutism. In all cases, however, when the deafness appears after the child has begun to speak, or where the causes mentioned [p. 106-131] are known to exist, the diagnosis is an easy matter. If, on the contrary, the deafness has made its appearance prior to the period at which speech is generally developed—whether the morbid changes of the organs of hearing causing deafness are congenital or acquired—a decision as to the fœtal or post-fœtal origin of the deafness is accompanied by great, indeed often insurmountable, difficulties. In such cases it is therefore of the greatest moment to obtain the most explicit information possible from the deaf-mute's friends, especially the parents, who are most likely to be able to give reliable information as to the diseases and pathological conditions which exist in the family, the importance of which has been pointed out in Chapter I. An opinion as to the origin of deaf-mutism can, as has been previously mentioned, only in exceptional cases be based upon objective examination of the individual. Such exceptional cases are, for instance, those in which visible and pronounced malformations of that part of the ear which is accessible to examination, clearly indicate that the deaf-mutism is the result of congenital changes of the auditory organ. Such cases are, however, very rare. Malformations in other parts of the body also indicate, though with a much less degree of certainty, that the condition in the ear is congenital; but, as mentioned p. 210, these cases are also rare. The objective examination of the ear in the great majority of cases offers nothing which can be relied upon with any degree of certainty, since on the one hand, pathological changes of the external and middle ear, which may, according to their nature, be acquired after birth, may very well exist in individuals whose deafness is the result of congenital malformations of the auditory organ, while on the other hand, less pronounced congenital changes of the external and middle ear (for instance, lesser degrees of microtia and macrotia, contraction of the external meatus, abnormal position of the drumhead, &c.), may very well appear in individuals with acquired deafness.

A final decision as to the congenital or acquired origin of a case of deaf-mutism must then in the majority of cases be entirely based upon inquiry, and even when explicit information is obtainable it is often difficult to arrive at a definite opinion. It will be always advisable to make inquiries whether the child's speech has developed in the same way as that of ordinary children of the same age, because non-professional persons' statements as to a child's power of hearing are often unreliable. Should the answer be in the affirmative, and should it be proved that the power of speech has been lost, or is arrested in its development from one or other of the causes mentioned in Chapter I. (acute brain-disease, scarlet fever, measles, &c.), it may be safely concluded that the deaf-mutism is of post-fœtal origin. This diagnosis is also justified, though with less certainty, when the above-mentioned causes have shown themselves during the first year of infancy, unless, of course, ample and satisfactory proof can be produced that the child has never possessed the power of hearing, or that the more remote causes of deaf-mutism mentioned in Chapter I. (unfavourable social conditions, heredity, consanguinity, &c.), have appeared with great force, in which cases a decision must remain doubtful. Should, however, the possibility of the existence of the direct influences (brain-diseases, scarlet fever, measles, &c.), be excluded, and it is proved that a child has never possessed the power of speech, it may be supposed that deaf-mutism is the result of congenital changes of the organs of hearing. This supposition is more warranted the greater proof there is that the more remote causes of deaf-mutism mentioned in Chapter I. have played their part in the case in question.

PROGNOSIS.—There is no doubt that the prognosis of the deafness which is the cause of deaf-mutism is highly unfavourable. This opinion has found its strongest expression in literature in a work by Kramer entitled "Die Taubheit der Taubstumnen is noch nicht geheilt, und ist überhaupt unheilbar" [58]. Curtis regarded the question with a more favourable eye, promising to reduce the number of pupils in deaf and dumb asylums if allowed to treat them [32, p. 39]. Of these two extremes Kramer's is doubtless the nearest to the truth; but there is no doubt that his opinion is somewhat exaggerated, as there exist some well authenticated cases of deaf-mutes whose power of hearing has been at least partially restored.

It is unnecessary to mention all the cases which have been reported in literature from the time of Herodotus (*see* p. 3), right through the middle ages. The majority are so shortly and insufficiently described as to render it impossible to present a prognosis of deaf-mutism based upon such facts. I shall only quote cases of quite recent date, and also opinions which have been formed by competent authorities.

It must be first admitted that the cases of complete or partial cure of deaf-mutism, elucidated by the more exact methods of investigation, which are at the disposition of modern otology, are very few, and reports based upon such cases are also small in number. Of these the following are the most important.

Toynbee has two cases of young adult deaf-mute females, whose deafness, which in neither case was total, had existed from childhood, who regained the power of speech after making use of an elastic speaking-trumpet, by the use of which their hearing was considerably improved [86, p. 412 and following].

Tröltsch writes as follows [141, p. 264]: "I remember several cases of children with suppuration from the ear, who were considered to be hopeless deaf-mutes by their friends, or who had been already placed in institutions for the deaf and dumb, whose deafness had been so much improved that they could be taught by means of ordinary instruction given alone, and whose speech was fairly good."

URBANTSCHITCH is of opinion that the hearing of vowels can be attained by a galvanic treatment [LEHRBUCH, 1880, p. 527].

In 1878, ALT reported a case [127] of acquired deafness which appeared after scarlet fever, when the child in question was in its third year, and which was so much improved by treatment that the child was able to attend an ordinary school. BOGG reported a similar case the following year [130, p. 43].

A. HARTMANN deduces from his personal experience that "beginnene Taubstummheit in ihrer Entwickelung aufgehalten werden kann, und auch die Möglichkeit vorliegt schon vorhandene Taubstummheit zu beseitigen" [126, p. 193].

Further, POLITZER writes as follows [148, vol. ii., p. 869]: "According to my experience, the prognosis of congenital deaf-mutism is more favourable than that of acquired. In a considerable number of cases in which I had observed congenital total deafness in childhood, I found that the power of hearing speech had increased some years later to one-third—1½ metres distance and more. This improvement in the majority of cases was only in the one ear, whilst the other remained deaf. I have only seen one case of complete cure."

POLITZER'S opinion is confirmed by information obtained from Dr. WILHELM MEYER'S clinic, where a case of congenital deafness has been observed in which the power of hearing was regained—without treatment—although on the first examination it was so slight, that it was doubtful whether the child, who was then four years of age, could hear a loud whistle with the right ear. Several other cases of congenital deafness improved without treatment as the patients grew older [189, p. 96].

UCHERMANN, whose treatment of deaf-mutes has been particularly successful, has sometimes obtained considerable improvement in the hearing of deaf-mutes, especially in cases of suppuration of the middle ear [168, p. 70]. The majority of UCHERMANN'S observations seem to be cases of acquired deafness.

ROHRER [193, p. 219] reports the case of a child of 15 years of age with congenital deafness, who, in the course of four months, regained the power of speech and of hearing as a result of the treatment applied.

Finally, LEMCKE gives an exhaustive report of several cases observed by him, of which the majority were seemingly congenital, where the power of hearing was greatly improved, either as the result of treatment, or spontaneously [210, p. 197, and following].

To the above cases of cure, or rather, of such great improvement in the power of hearing that the secondary mutism was obviated or removed, the following which have come under my own observation may be added.

Case No. 26. Jensine, N., was born in 1870, of healthy parents who were not related, and in whose family there were no cases of deafness, deaf-mutism, brain-disease, &c. Two other children are healthy and normal. The patient and her mother declare that she was totally deaf until her seventh year, when she began to hear a little, from which time the power of hearing has gradually increased year by year, so that she can now understand ordinary speech when tolerably loud and at no great distance. From her eighth to her sixteenth year she was educated by the oral method, at an institution for the deaf and dumb. On the 28th of October, 1893, she was unable to hear a watch, but could hear an A tuning fork (which is heard by normal subjects for 30 seconds) for four and six seconds in the right and left ear respectively. There was no cranio-tympanic conduction. The membrana tympani was dull and thickened on either side; the malleus was retracted and adherent to the wall of the labyrinth by its manubrium. Catarrh of the nose, naso-pharynx and throat existed, and there was stenosis of both tubæ, especially the right. No treatment has ever been applied.

Case No. 27. Sanne, P., was examined for the first time on the 25th of April, 1890, when she was six years of age. The mother's mother, and father's mother, both had deficient powers of hearing; both parents are slightly deaf, and a sister of the mother has suffered from suppuration of the tympanic cavity. Otherwise there was nothing bearing upon the etiology of deaf-mutism in the family. She weighed four pounds at birth, and did not thrive during the early years of childhood, and she suffered also from rickets. She did not begin to speak until four years of age, and then only uttered some few words, which made the parents first suspect that the child was deaf. The power of hearing varied; at times = 0, at times certain words could be heard when shouted into the ear. The stock of words was very limited, and the voice was monotonous. It was found on measuring the hearing power, that she could understand words shouted by the parents, but not by strangers. She could not hear either the ticking of a watch or a tuning-fork. The tympanic membrane on either side was greyish, dull and greatly thickened; the malleus was slightly defined, but in a normal position. There were no abnormalities in the nasal cavity. The naso-pharynx was filled with adenoid growths, which were removed on October the 10th, 1890, under chloroform, after injection of air into both tubæ, of which the one was contracted. The hearing improved immediately after the operation, and on the 21st of October, 1890, the patient was able to hear a loud voice at the distance of three feet. The power of hearing has since increased gradually under regular injections of air into both tubæ during the first year after the operation. The patient can now (December, 1893), hear ordinary speech, even at some distance (6 to 8 feet). The power of speech has developed by degrees, and has nearly lost its monotonous tone. The parents who were formerly afraid that the child was an idiot, because it could not speak, declare that its mental powers are good, though it is somewhat backward.

It is then evident that there are instances of deaf-mutism which have been cured, or rather where the deafness has so far spontaneously improved, that the secondary mutism has been avoided, so that the subjects have been able to communicate with their fellow creatures by means of speech and hearing. Several circumstances indicate that this may take place both in cases of acquired and, perhaps especially, of congenital deafness. It has also been proved that a suitable treatment has produced a similar result in a still greater number of cases of deaf-mutism. When we remember that it is only quite recently that any rational attempts at treatment in cases of deaf-mutism have become general, it is not to be wondered at that the results hitherto published are so few. It is, however, to be hoped that as otological methods are constantly improving and developing, the number of cases of deaf-mutism in which the deafness is cured or improved will increase, and that the utterly hopeless prospect which is generally placed before deaf-mutes will, by degrees, give place to a somewhat more favourable view. Should these hopes be disappointed, we are, however, justified in supposing that the future of the deaf-mute will be at least improved by a greater attention being paid to the ear-disease from which they so often suffer; for even slight improvements in the power of hearing are of great practical importance, since deaf-mutes with some hearing are much better able to learn to speak and to understand others' speech than those who have no power of hearing at all, or only feeble traces of it. Greater attention to the ears of deaf-mutes will also doubtless prevent many from succumbing to the dangerous complications which often result from the suppuration of the middle ear appearing in deaf-mutism, of which the post-mortem examination reported by me is a striking example [214].

The above remarks refer principally to the primary and most important symptom in deaf-mutism—the deafness. The mutism as a rule, is closely connected both in its appearance and intensity with the deafness. There is, therefore, no necessity for entering more particularly into its prognosis, excepting in so far as it is dependent upon whether the deaf-mute is taught to speak or not. It may be remarked that although the chances of removing the mutism are greater, the better the hearing, and the later the deafness has appeared, intelligence, and perhaps also, a greater or less ability to acquire speech, play some part in this respect.

TREATMENT.—I have already mentioned the cases which have been reported in literature in which deaf-mutism has been treated with the object of removing or improving the deafness. It has also been shown that in some few cases such a treatment has produced considerable improvements in the power of hearing, and that these improvements have been of the greatest importance to the individuals in question.

It is as yet difficult to say in what cases treatment is indicated, as we have not reached further than to the first experiments in that direction. I have latterly endeavoured to act according to the following rules when deaf-mutes have been brought to me for treatment. Treatment is most decidedly indicated when the deaf-mute suffers from suppurative inflammatory processes of the middle ear. Treatment can at least in such cases remove, or diminish, the danger which always attaches to suppuration of the middle ear, viz., that it will spread, or produce diseases in other organs. Uchermann's experience also proves that the defect in the power of hearing may be diminished in cases of this nature [168, p. 70, and following], a circumstance the practical importance of which has been mentioned before. Treatment is also, I think, indicated in cases in which there are some traces of the power of hearing, and especially when this power exists with varying intensity, and where there are also symptoms of catarrhal conditions in the middle ear (catarrhal changes of the membrana tympani, retraction of the manubrium of the malleus, contraction of the tubæ, &c.); also catarrh of the mucous membranes adjacent to the ear, especially when there also exists hypertrophy of the adenoid tissue in the naso-pharyngeal cavity. If the cranio-tympanic conduction still exists, the chances in this group of cases seem to be still more favourable. In cases of catarrh of the middle ear and adjacent mucous membranes, where no signs of hearing can be discovered after repeated examination, I have also attempted treatment; though I am not certain that such a course gives any hope, as my experience, which is not however very large in this group of cases, has not been favourable.

In all the above-mentioned groups the indications are the same, whether the deafness is congenital or acquired. Various circumstances, which have been pointed out in the foregoing pages, indicate that total deafness resulting from acute infectious diseases, especially cerebro-spinal meningitis and scarlet fever, and accompanied by slight catarrhal changes, is due to a constant labyrinthine disease which defies all treatment.

So far as the nature of an ultimate treatment is concerned, it must be observed that general and special otiatric principles must be used as guides, and the treatment in the majority of cases should be local. In a case such as Case No. 26, treatment by injections of pilocarpin directed against the exudations which doubtless existed in the labyrinth would be advisable. I was very desirous of trying this treatment in the case mentioned, but was prevented by the mother, who said, and with some justice, that doctors had not as yet been able to do anything for her daughter's hearing, but that it had been restored by the goodness of the Almighty, in whose hands she also left the future.

Treatment in other than the above-mentioned cases of deaf-mutism is of course justified when it is not accompanied by any danger to the patient, when it is dictated by otological principles, and when it is certain that the anatomical cause of the deafness is not situated in the brain. It remains for the future to show what chance of improvement such cases have.

Urbantschitsch's treatment, which has been quite recently published, is also deserving of mention. It consists in regular acoustic exercises, intended either to awaken or to improve the power of hearing in deaf-mutes, and there is every reason to look forward to more exhaustive information as to the results of such treatment with considerable interest.

The above remarks on the treatment of deaf-mutism have exclusively dealt with the deafness from which the mutism results. I will not go further into the treatment of mutism by a special method of instruction by which deaf-mutes are taught to speak, partly because this subject is not included in the aim of the present work, and partly because this important question is of a more pedagogical nature, and has been already the subject of a very considerable literature. There can no longer be any doubt that the method of instruction by which the deaf-mutes are taught to speak, and which, although it originated with a Spanish monk, Pedro de Ponce, *injuria temporum*, has received the name of *the German method*, is superior to the so-called *French method*, by which deaf-mutes are taught to communicate with their fellow creatures by means of signs. The question is whether the oral method is that which is most servicable for *all* deaf-mutes, or whether there are not some deaf-mutes who have such a great difficulty in acquiring speech, that too great labour is expended upon learning it, to the disadvantage of other useful acquirements and knowledge necessary to them in after life. The solution of this problem must be left to pedagogues; but it may not be out of place to remark that in the discussion, which is now raging, it would seem that it is often forgotten that the use of the one or other method by deaf-mutes is not the end but the means.

It will be seen from the above, that when a child is proved to have such deficient power of hearing that deaf-mutism is the result, a removal of that deaf-mutism by treatment can only be hoped for in very exceptional cases. Therefore there is a still greater reason for considering with especial attention the question of *the prevention of deaf-mutism*. H. SCHMALTZ and LEMCKE, in particular, have done this in their respective works [161 and 210], and both these authors, along with several others, have with justice laid especial stress upon an improvement of the social and hygienic conditions which play so important a part as remote causes of deaf-mutism*, and upon a rational treatment of the ear-diseases of children which are known to cause deaf-mutism.

So far as the first of these two causes is concerned, it is certain that hygienic conditions are almost everywhere undergoing a great improvement; there is, therefore, no necessity to point out evils of this kind, or the means of redressing them. But there is still much to be desired in the treatment of the ear-diseases which lead to deaf-mutism. Every otologist has seen striking examples of the want of attention paid to ear-diseases in children, and many children are admitted into deaf and dumb institutions with ear-diseases which have never been submitted to medical examination, not to mention treatment. This is especially the case with suppuration of the middle ear, which, either resulting from acute infectious disease or from any other cause, is frequently considered rather as a natural remedy than as a disease which calls for treatment. It is to be hoped that the recognition which is by degrees, though slowly, being yielded to otology by the medical profession, will make itself felt in the prevention of deaf-mutism by opening the eyes of practitioners to the importance of ear-diseases and their treatment, and also that the general public may be led to form other opinions upon the subject than those now prevalent. There is much to indicate an improvement in this direction, especially since otiatric methods of investigations and treatment have become more generally known among medical men, and the former prejudice against this speciality seems to be dying out more and more.

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*As pointed out in the first Chapter, both heredity and consanguinity are important remote causes of deaf-mutism. But it cannot be expected that even a general knowledge of the importance of these factors would do much towards the prevention of deaf-mutism.

No more recent work which has especially treated of the nature and character of deaf-mutism, has appeared without an urgent appeal that the ear-diseases of deaf-mutes might be subjected to a careful examination and eventual treatment before the individuals in question were considered to be hopeless deaf-mutes and sent to a deaf and dumb institution. These appeals have as yet been in vain, and will doubtless remain so for some time. Truth is, however, not always heard and received by virtue of its own worth, but often only because it is constantly repeated. It is, therefore, not with the hope of attaining what others have failed to attain, but only to repeat what my predecessors have said before me that I conclude this work with an urgent appeal founded upon facts here set forth, *to submit all children who suffer from deafness which threatens to cause, or has caused deaf-mutism, to a rational examination of the ears, and of the adjacent mucous membranes, and eventually to make the existing diseases the subject of a rational treatment.*

APPENDIX.

POST-MORTEM EXAMINATIONS OF DEAF-MUTES REPORTED IN LITERATURE.

(The year after the name of the investigator indicates either the date of the post-mortem examination in question, or the date of its publication. The anomalies described were bilateral unless *Right* (R) or *Left* (L) is added. Where nothing else is stated the respective organs were (or must be supposed to have been) in a healthy condition. The morbid changes of the labyrinth refer, if nothing particular is added, to the osseous labyrinth.)

A.—*Cases in which the Deafness was stated to be Congenital.*

I.—MERSENNUS, 1679 [15, *lib* i., *sect* xix., *observ* iv., § 1, p. 343]. Incus absent.

II.—BONET, TH., 1679 [*ibid*, § 2]. Incus absent.

III.—BAILLY, L., 1679 [*ibid*, § 3, p. 344]. A boy, aged 3. All the ossicles one-third of their natural size.

IV.—MONDINI, CARLO, 1791 [21, p. 421]. A boy, aged 8; died from gangrene of the foot after contusion. The aquæductus vestibuli was very wide. The cochlea was only 1½ turn; instead of the last turning a large cavity existed.

V.—HAIGHTON, 1792 [22, p. 4]. A man, aged 30. The whole labyrinth was filled with caseous matter. The auditory nerve was smaller than usual.

VI.—MONTAIN, 1819 [22, p. 114]. A boy; completely deaf; died from "adynamic fever." The ossicles were wanting; the fenestra rotunda and ovalis were absent; the tympanic cavity was filled with mucus. The labyrinth was absent.

VII.—Ibsen and Mackeprang, 1826 [216, specimens Nos. 14 and 15]. A male, aged 17, having a sister born deaf and dumb, and the mother insane; died from tuberculosis. The aquæductus vestibuli was very wide. The posterior semicircular canal was visible on the posterior face of the petrous bone. (The left side only was examined).

VIII.—Ibsen and Mackeprang, 1829 [216, Nos. 20 and 21]. A girl, aged 12; died from tuberculosis. The internal auditory meatus was exceedingly narrow.

IX.—Ibsen and Mackeprang, 1829 [216, Nos. 22 and 23]. A boy, aged 15; died from tuberculosis. Of the vestibule only a trace was left. The internal semicircular canal was wanting; the ampullar ends of the superior and external canal formed one canal. The first turn of the cochlea communicated by means of an aperture with the internal auditory meatus, which was wide and short, forming a groove.

X.—Ibsen and Mackeprang, 1829 [216, Nos. 24 and 25]. A boy, aged 8; having a brother deaf and dumb and a sister born deaf (*see* No. xvii.); died from nephritis and pleurisy. The aquæductus vestibuli was wide. The lamina spiralis and the modiolus were only present in the first turn of the cochlea; the partition wall between the second and third turn was wanting, the superior part of the cochlea forming a large cavity.

XI.—Ibsen and Mackeprang, 1830 [216, Nos. 28 and 29]. A boy, aged 9. The aquæductus vestibuli was widened. The semicircular canals were narrowed. The lamina spiralis and the modiolus were only present in the first 1½ turn of the cochlea, the partition walls between the remaining parts of the cochlea were wanting, the superior part of the cochlea forming a large cavity; the remaining part of the scala vestibuli was very widened.

XII.—Ibsen and Mackeprang, 1830 [216, Nos. 30 and 31]. A boy, aged 10; died from tuberculosis. The tympanic cavity was very narrowed; the membrana tympani and the ossicles were wanting; the entrance to the Eustachian tube was closed; The cellulæ petrosæ were considerably enlarged. *R.*, posterior semicircular canal was partially closed by means of an osseous mass. *L.*, superior and exterior semicircular canals were partially closed.

XIII.—Ibsen and Mackeprang, 1831 [216, Nos. 36 and 37]. Male, aged 16; had a brother deaf and dumb, who died from tuberculosis. The aquæductus vestibuli was widened. The modiolus and the lamina spiralis were only present in the first half turn of the cochlea, in the top of which a large cavity was produced. *L.*, the scala vestibuli was widened, while the scala tympani was narrowed.

XIV.—Ibsen and Mackeprang, 1831 [216, Nos. 40 and 41]. Female, aged 13; had a brother deaf and dumb, who was also born deaf. The *L.* posterior semicircular canal was partially closed by a calcareous mass.

XV.—Bochdalek, V., 1835 [56, p. 10]. Boy, aged 9; died from tuberculosis. There was suppuration of the tympanic cavity. The entrance from the vestibule into the scala vestibuli was closed by a thick membrane. The internal auditory meatus was narrow. *R.*, the semicircular canals were wanting. *L.*, instead of the semicircular canals two tubes existed communicating with each other.

XVI.—Hyrtl, J., 1836 [48, p. 421]. Boy, aged 7; completely deaf; died from "tabes mesentericus." There was harelip and a small congenital fissure in the sternum. The drumhead was thickened; the malleus and the incus were atrophied; the tensor tympani was atrophied; the promontory was wanting, and the whole tympanic cavity was enlarged. The aquæductus vestibuli was wide. The lamina spiralis existed only in the first 1½ turn. There was atrophy of the nervous elements of the auditory nerve; the branches to the vestibule and the cochlea ended in a brown mass. The floor of the fourth ventricle was covered by the cystically degenerated arachnoidea. *R.*, the crura of the stapes were wanting, the basis was anchylosed; the musculus stapedius was wanting. The external semicircular canal was absent; the superior canal was reduced to two small grooves in the vestibule; the posterior canal was conspicuous on the posterior face of the petrous bone, and contained a narrow opening here which was only closed by the dura mater. *L.*, the incus was atrophied. The external semicircular canal was wanting.

XVII.—Ibsen and Mackeprang, 1837 [216, Nos. 52 and 53]. A girl, aged 10, with two brothers deaf and dumb, the temporal bones of the one forming the specimens Nos. 24 and 25 (*see* No.

X.); died from tuberculosis. The modiolus and the lamina spiralis existed only in the first 1½ turn of the cochlea, the top of which was transformed into a large cavity. The aquæductus vestibuli was much widened.

XVIII.—Bochdalek, V., 1838 [56, p. 199]. A girl, aged 10; completely deaf; a brother of the father born deaf; died from scarlet fever and meningitis. The fenestra rotunda formed a slit. The auditory nerve was very thin after having sent a large bundle to the facial nerve.

XIX.—Cock, Edw., 1838 [51, p. 296]. A boy, aged 12, suffering from epileptic fits; died from consumption. The drumhead was retracted; the middle ear was filled with granulations and pus. The cochlea was absent, its entrance from the vestibule and the fenestra rotunda leading to two small cavities. The auditory nerve was thin and hard. The substance of the brain was very hard. The petrous bone was of unusual size and abnormal hardness (like ivory). *L.*, the membrana tympani was closely adherent to the promontory; the incus was anchylosed to the inner wall of the tympanum.

XX.—Römer, Ant., 1839 [52, p. 8]. A boy, aged 8; one of his brothers or sisters was deaf and dumb, and there was abnormal asymmetrical shape of the cranium. He died from "nerve fever." The tympanic cavity was large, the promontory being absent; the base of the stapes was anchylosed, its posterior crus was adherent to the canal of Fallopius; between the incus and the stapes an abnormal ossicle existed; the musculus stapedius and laxator tympani were absent; the fenestra rotunda was absent. The superior and the external semicircular canals were short. The cochlea was very short, forming only 1¾ turn. The aquæductus cochleæ was only present in its external part. The meatus auditorius internus was very narrow.

XXI.—Edwards, 1840 [55, p. 793]. A boy, age unknown; was completely deaf. The membrana tympani and the ossicles were absent on the one side. The semicircular canals were filled with caseous matter.

XXII.—Bochdalek, V., 1842 [60, p. 129]. A woman, aged 24; was completely deaf; a brother and a brother of the mother were deaf-mutes, and she died from typhus. *R.*, the external auditory meatus was narrowed. The tympanic cavity was small;

the fenestra ovalis was deeply situated. The vestibule was narrowed. The posterior semicircular canal was absent; instead of the canal were seen several small cavities in the bone. The auditory nerve was thin (atrophic), without communication with the facial nerve. The petrous bone was considerably enlarged; the internal auditory meatus was narrow. *L.*, the posterior semicircular canal was short and flattened. Deposits of osseous masses existed on the posterior face of the petrous bone.

XXIII.—Oppolzer and Dlauhy, 1846 [66, vol. i., p. 72]. A man, aged 35; somewhat imbecile; had a sister born deaf-mute. He died from typhus. Atrophy of the cerebellum was discovered.

XXIV.—Michel, 1851 [90, p. 55]. An individual, aged 12. The vestibule was enlarged towards the external semicircular canal, which was absent. *R.*, the posterior half of the superior, and the anterior two-thirds of the posterior, semicircular canals were absent; the remaining parts of the canals were contracted. The auditory nerve was hard without any microscopical abnormalities. *L.*, the middle of the posterior and the superior semicircular canal was absent.

XXV.—Triquet, 1854 [79, p. 474]. A boy, aged 15; feeble-minded. Chronic catarrh of the tympanic cavity; the tympanic membrane was adherent to the inner wall of the tympanum; the stapes being anchylosed. *R.*, the chorda tympani was absent.

XXVI.—Triquet, 1854 [*ibid*, p. 476]. A boy; died from "disease of the chest." *R.*, the middle of the posterior semicircular canal was absent. *L.*, all the semicircular canals ended in a *cul de sac* shortly after their origin. The interior of the cochlea formed a large cavity.

XXVII.—Toynbee, Jos., 1860 [86, p. 402]. A woman, aged 40; insane for ten years. The anterior limit of the superior semicircular canal terminated in a *cul de sac* after having attained its half length; the greater portion of the posterior semicircular canal was absent.

XXVIII.—Toynbee, Jos., 1860 [*ibid*, p. 403]. A man, aged 50; died from "fever." The osseous semicircular canals were large, but without membranous tubes. *R.*, the membrana tympani was thicker than natural, and perforated by a polypus attached to it. A membranous band connected the incus, the stapes, and the tensor tympani muscle. *L.*, one of the semicircular canals was very contracted.

XXIX.—Michel, 1863 [90, p. 57]. A boy, aged 11. The stapes and the os lenticulare were absent. The mastoid process was absent. The entire labyrinth was absent. The auditory nerve was missing. The petrous bone was deformed, showing only two faces, an inferior and a superior.

XXX.—Dardel, 1864 [91, p. 155]. A man, aged 27; died from erysipelas. *R.*, the stapes was anchylosed, and the fenestra rotunda absent. The scala tympani opened into the vestibule. *L.*, the fenestra rotunda was very contracted.

XXXI.—Luys, I., 1875 [115, p. 313]. A man, aged 72; died from inflammation of the lungs. The cortical layer of the cerebrum was atrophic in several places about the cuneus, yellow, colloid, and œdematous, and there was atrophy of the nerve fibres from here to the thalamus.

XXXII.—Moos, S. [124, p. 247]. A woman, aged 29; died from tubercular meningitis. The mucous membrane of the tympanum was hypertrophic; the fenestra rotunda was closed by osseous substance. A large quantity of otoliths and colloid corpuscles were present in both sacculi and in the membranous ampullæ and the membranous lamina spiralis. *R.*, the ossicles were anchylosed. *L.*, the membrana tympani was retracted, and there was diminished mobility between the malleus and the incus, and anchylosis in the other joints.

XXXIII.—Baratoux, 1881 [138, p. 91]. A man, aged 50; died from broncho-pneumonia. The organ of Corti was absent, and there existed degenerative changes of the auditory teeth and the membrana basilaris. The auditory nerve was atrophic with instertitial neuritis.

XXXIV.—Politzer, A., 1882 [148, p. 867]. A man, aged 61; died from chronic internal hydrocephalus with pachymeningitis. The membrana tympanica secundaria was very thin and movable. The striæ acusticæ were very little developed. *L.*, the auditory nerve was degenerated.

XXXV.—Politzer, A., 1882 [*ibid.*, p. 868]. A girl, aged 11. The crus longum incudis was elongated and bent to a right angle in the middle, the stapes being adherent by means of fibrous ligaments. *R.*, the membrana tympani exhibited cicatrices; the corpus incudis was enclosed in a fibrous mass; the niche of the fenestra rotunda was filled with fibrous tissue. *L.*, the membrana tympani was perforated,

XXXVI.—Larsen-Utke, 1887 [192, No. 5]. A boy, aged 5, with two brothers and sisters born deaf-mutes; died from diphtheria. *R.*, the basis of the stapes was anchylosed. (The left side was not examined).

B.—*Cases in which the Deafness was stated to be Acquired after Birth.*

XXXVII.—Itard, 1821 [31, vol. i., p. 393]. A man, aged 75; deaf after an apoplectic fit in childhood, but not totally. *R.*, the auditory nerve was only one-third of its natural size, and of fibrous structure, no part having the appearance of a nerve. *L.*, the same changes existed, only less pronounced.

XXXVIII.—Mürer, T. C., 1825 [34, p. 15]. A boy, aged 11, whose deafness was caused by an acute febrile disease during his second year; died from tuberculosis. *L.*, the semicircular canals were almost entirely replaced by spongy bony tissue. (The right side was not examined).

XXXIX.—Ibsen and Mackeprang, 1827 (216, specimens Nos. 16 and 17]. A boy, aged 16; deaf since his fourth year from an unknown disease; died from tuberculosis. The stapes was small and deformed. The petrous bone consisted entirely of hard bone, in which the labyrinth was replaced by two small cavities, which corresponded to the vestibule and the cochlea.

XL.—Bochdalek, Vinz., 1831 [56, p. 9]. A boy, aged 16; deaf after a serious disease when 2 years old; died from pulmonary consumption. All the semicircular canals ended in a *cul de sac* without communication with the vestibule.

XLI.—Ibsen and Mackeprang, 1831 [216, Nos. 32 and 33]. A girl, aged 13; deaf from measles when 2½ years old; died from tuberculosis. Caries of the tympanic cavity existed, with complete destruction of the membrana tympani and the ossicles. The external semicircular canal was closed in the middle by means of bony tissue; the superior canal partially contracted.

XLII.—Ibsen and Mackeprang, 1831 [216, Nos. 34 and 35]. A lad, aged 17; deaf from a disease when 6 years old; died from tuberculosis. The vestibule was completely filled by an osseous mass. *R.*, all the semicircular canals were filled with a similar mass. The first turn of the cochlea was filled with a mass which was something between a calcareous and an osseous substance.

XLIII.—Ibsen and Mackeprang, 1832 [216, Nos. 38 and 39]. A girl, aged 13, whose deafness was caused by a disease during the second year of her life; died from meningitis. *R.*, the posterior and the superior semicircular canals were partially filled with an osseous mass.

XLIV.—Ibsen and Mackeprang, 1832 [216, Nos. 42 and 43]. A lad, aged 17; lost his hearing during an illness when 5½ years old, and died from tuberculosis. Caries of the walls of the tympanic cavity existed, with destruction of the ossicles and the membrana tympani. *L.*, the fenestra ovalis was closed by an osseous mass. The vestibule was reduced to a very small cavity, the aquæductus vestibuli being wide. All the semicircular canals were partially filled with an osseous mass. The cochlea was similarly filled.

XLV.—Ibsen and Mackeprang, 1832 [216, Nos. 44 and 45]. A woman, aged 16, who lost her hearing during measles in the fifth year of her life; died from tuberculosis. The fenestra rotunda was closed by an osseous mass. All the semicircular canals were also filled with an osseous mass. The cochlea was also filled with an osseous mass.

XLVI.—Ibsen and Mackeprang, 1832 [216, Nos. 46 and 47]. A girl, aged 15, who became deaf when six months old, the result of convulsions due to teething; died from tuberculosis. The superior and the posterior semicircular canals were closed in their middle; the external canal was contracted in its middle.

XLVII.—Ibsen and Mackeprang, 1833 [216, Nos. 48 and 49]. A girl, aged 14; deaf, when 6½ years old, from meningitis (pains in the head, vomiting, coma); died from tuberculosis. The vestibule was considerably diminished in size. All the semicircular canals were filled with an osseous mass, which also filled the cochlea.

XLVIII.—Ibsen and Mackeprang, 1833 [216, Nos. 50 and 51]. A girl, aged 16, who was supposed to have lost her hearing in early childhood; died from tuberculosis. *R.*, the stapes and the crus longum incudis were absent.

XLIX.—Craigie, D., 1833 [46, p. 120]. A woman, aged 20, who could hear until 18–20 months old. The tympanic cavity and the antrum mastoideun were filled with pus; the ossicles were deprived of their mucous membrane. *R.*, the stapes was anchylosed. *L.*, the stapes was absent, and the membrana tympani was perforated. (It appears as if Craigie had not examined the labyrinth).

L.—Bochdalek, Vinz., 1834 [56, p. 8]. A woman, aged 18, whose deafness was caused by an illness during the third year of her life; died from "ulcerations of the intestines." The stapes was anchylosed; the tympanic aperture of the Eustachian tube was contracted; the membrana tympanica secundaria was very much thickened. In the vestibule the eminentia pyramidalis was absent. The semicircular canals were contracted, their walls being thick and like ivory.

LI.—Bochdalek, Vinz., 1838 [56, p. 202]. A man, aged 24, whose deafness was caused by "nervous debility" during his third year; died from pulmonary consumption. The vestibule was contracted, the communication with the cochlea was closed by osseous substance; the aquæductus vestibuli was absent. The superior and the posterior semicircular canals were absent and replaced on the right side by two small cavities, on the left by spongy substance; the external canal was filled with a white osseous mass. The cochlea was also filled with the same osseous mass; the internal aperture of the aquæductus cochleæ being closed. The auditory nerve was thinner than usual, and discharged in the internal auditory meatus a thick bundle of fibres to the communicans faciei; the ramus cochleæ was atrophic.

LII.—Bochdalek, Vinz., 1839 [60, p. 132]. A boy, aged 12; completely deaf after a serious illness during his second year, consequent on a fall from a table; died from pulmonary tuberculosis. The posterior semicircular canal was flattened and shortened, its posterior limb ending in a *cul de sac*. *R.*, the superior semicircular canal consisted of two small closed cavities. *L.*, the external semicircular canal was contracted in its posterior limb.

LIII.—Bochdalek, Vinz., 1840 [60, p. 269]. A woman, aged 40; completely deaf from disease which appeared during her seventh year, and was complicated with fever and fœtid discharge from both ears, lasting altogether for twelve weeks; died from pulmonary tuberculosis. The membrana tympani was absent; the tympanic cavity was irregularly widened with thickening of its mucous membrane; the malleus and the incus being absent, and the cavity filled with caseous masses; the osseous portion of the Eustachian tube was to a great part filled with an osseous mass, while the cartilaginous portion was substituted by an imperforated cartilaginous mass; the chorda tympani being absent. *R.*, the posterior semicircular canal was partially filled by an osseous mass. The scala tympani was filled with an osseous mass in a little more than the half of the first turn, and the scala vestibuli was from this part to its summit very contracted. The auditory nerve was atrophic. The whole petrous bone was very hard. *L.*, the fenestra rotunda was closed. The semicircular canals were substituted by an ivory-like mass. The whole of the cochlea, except a small cavity in its top, was also filled with an osseous mass.

LIV.—Pappenheim, S., 1842 [59, p. 296]. A man, aged 21; stated only that the deafness was acquired after birth; died "hectic." *R.*, the tympanic cavity and the Eustachian tube were filled with mucus. Concentric stratiformed amber-colored corpuscles (cholesterine corpuscles) were deposited under the nerves of the sacculus rotundus. *L.*, the Eustachian tube was filled with mucus. The same corpuscles were present in the ampullæ and the membranous semicircular canals.

LV.—Schwartze, H., 1851 [95, p. 281]. A lad, aged 17, whose deafness, according to his mother, was caused by a blow on his larynx when between two and three years old; died from peritonitis. The membrana tympani was perforated like a sieve. The entrance to the Eustachian tube, and the cells of the mastoid process were filled with cellular tissue, which contained cholesterine.

LVI.—Schwartze, H., 1869 [102, p. 296]. A girl, aged 9; completely deaf from meningitis, which occurred during her fourth year; died from scarlet fever. The mucous membrane of the tympanic cavity was swollen, thickened, and covered with mucus. The vestibule was wanting; on the right side it was substituted by a tissue consisting of nerve fibres and a small quantity of connective tissue; on the left side by a hard osseous mass. The semicircular canals were wanting. The cochlea was absent. *R.*, the auditory nerve divided into its two terminal branches, which were, however, without any nervous terminal apparatus. *L.*, the fenestra rotunda was wanting. The auditory nerve diminished in circumference, and was without terminal branches.

LVII.—Moos, S., 1871 [105, p. 98]. A man, aged 50; during his fourth year discharge from the ear and caries of the mastoid process; during his fifth year "Mundfäule," after which disease complete deafness occurred; he died from a cerebral tumour. *R.*, the membrana tympani was completely wanting and substituted by a bony mass; the tympanic cavity and the Eustachian tube, to a great extent, were filled by osseous tissue; the malleus and the incus were wanting; the musculus tensor tympani was wanting; the fenestra rotunda was closed by osseous tissue; the stapes, only existing partially, was anchylosed. The cavity of the vestibule was contracted by means of two warty exostoses; the walls of the membranous contents thickened considerably and enclosed a great number of otoliths. The walls and the partition walls of the cochlea were sclerotic. *L.*, the external auditory meatus was closed by a bony mass; the entire middle-ear being substituted by a large cavity, which contains a large cholesteatomatous growth. The vestibule was absent, being replaced by bone. All the semicircular canals were closed by bone. The cochlea was also filled up by a bony mass.

LVIII.—Moos, S., and Steinbrügge, H., 1881 [159, p. 96]. A girl, aged 11, who lost her hearing during her fourth year with symptoms of meningitis, hearing of vowels being, however, preserved; died during eclamptic fits. The petrous bone was very large. *R.*, numerous colloid corpuscles and molecular detritus were found in the walls of the utriculus. The same formations were present in the tubes of the semicircular canals and in the perilymphatic spaces of this part. Partial obliteration of the first turn of the cochlea by means of formations of connective and osseous tissue existed.

LIX.—Politzer, A., 1882 [148, vol. II., p. 809]. A boy, aged 13; completely deaf after a disease with fever lasting a fortnight during his third year, and complicated with eclamptic fits and discharge from both ears; died from peritonitis. The stapes was anchylosed, and the fenestra rotunda closed by a bony mass.

The cavity of the vestibule was contracted by formation of bone. All the semicircular canals were absent, being substituted by an osseous mass. The cochlea was also filled with an osseous mass.

LX.—Politzer, A., 1882 [*ibid*, p. 822]. A boy, aged 9; complete deafness after an acute disease (which occurred after he had been subject to convulsions for a whole year during his third year), and which lasted eight days, and was connected with coma, followed by staggering gait; died from acute meningitis. The base of the stapes adhered to a membrane in the vestibule. The ganglionic layer of the canal of Rosenthal was atrophic in the first turn of the cochlea, and the nerve fibres to the lamina spiralis ossea, also the auditory teeth were wanting. *L.*, only a narrow margin was left of the membrana tympani, in which small deposits of a calcareous mass were present.

LXI.—Uchermann, 1883 [207, p. 70]. A male, aged 18, whose deafness was due to scarlet fever when 2½ years old; died from tuberculosis. The fenestra rotunda was closed by a bony plate. The convolution of Broca was somewhat more narrow than usual; the gyrus temporalis superior being thinner than normal. *R.*, there was osseous anchylosis of the stapes. The vestibule was contracted and lined with thickened periosteum, and presented no membranous contents. The semicircular canals were replaced by a tube of one-and-a-half centimetres length, representing the superior canal and filled with fibrous tissue. Only the outlines of the cochlea were visible, its cavity being replaced by osseous tissue, except the first turn which formed a small cavity. *L.*, the membrana tympani was perforated in four different places; the tympanic cavity and all the cavities of the petrous bone being filled with pus and detritus.

LXII.—Schultze, Fr., 1885 [186, p. 1]. A girl, aged 13, who became completely deaf in her ninth year while suffering from symptoms of meningitis (cerebro-spinal meningitis?). Had the entire labyrinth filled with osteoid tissue and round cells. Atrophy of the auditory nerve existed. *L.*, the striæ acusticæ were absent.

LXIII.—Larsen, P. C., and Mygind, Holger, 1889 [188, p. 188]. A man, aged 27; completely deaf from a disease resembling meningitis (probably epidemic cerebro-spinal meningitis) when two years old; died from tuberculosis. The bases of the stapes was absent; the fenestra ovalis was closed partially by a membrane and partially by the posterior limb of the stapes; the fenestra rotunda was closed by a bony plate. The vestibule was diminished in size and altered in shape, and without any membranous contents; the aquæductus vestibuli was closed. The semicircular canals were completely filled by an osseous mass. Only the cavity of the first turn of the cochlea was present, the remaining turns being filled with an osseous mass; the aquæductus cochleæ was closed. The auditory nerve was partially atrophied. The third frontal convolution of the brain was thinner on the left side than on the right.

LXIV.—Moos, S., 1889 [215, p. 69]. A girl, aged 12, who was completely deaf after scarlet fever and diphtheria when nine years old; died from meningitis. The membrana tympani was almost completely destroyed; there was pus in the tympanic cavity; the malleus and the incus were absent; there was degeneration of the muscles of the tympanic cavity, and residua of necrosis of the tympanic wall. The right external and the left superior semicircular canals were filled with fibrous tissue, which on the right side was partially transformed into osseous tissue. The cavity of the cochlea to a great extent was filled with osseous tissue, especially in the basal turn; the ductus cochlearis and its contents were almost completely destroyed. Besides the pathological changes mentioned, there were numerous other abnormalities as the result of the scarlatineous otitis media.

LXV.—Bryant, W. S., and Sears, H. F., 1890 [208, p. 174]. A woman, aged 60 (Laura Bridgeman); was completely deaf and blind after scarlet fever when two years old. There was destruction of the membrana tympani; the ossicula auditus were absent; there was osseous occlusion of the tympanic aperture of the Eustachian tube and hyperostosis of the tympanic walls; the fenestra rotunda and ovalis were closed with osseous tissue; the mastoid process was sclerotic. Flattening was found of the cerebral convolution of the left frontal lobe and of the insula. *L.*, the tympanic cavity was closed by a membrane.

LXVI.—Mygind, Holger, 1891 [198, p. 310]. A man, aged 27; had total loss of hearing during measles in his second year; died from pneumonia. The fenestra rotunda was absent; the muscles of the tympanic cavity were missing. There were no membranous contents in the vestibule and the semicircular canals. The cochlea to a great extent was filled with osseous tissue, a part of its basal turn only being present as two small cavities without any membranous contents. The posterior parts of the inferior convolutions of the left frontal lobe were flattened. *R.*, the mastoid process was sclerotic; the membrana tympani thickened and with a calcareous deposit. *L.*, the membrana tympani was almost completely destroyed, the tympanic cavity being filled with gelatinous matter.

LXVII.—HABERMANN, J., 1889 [205, p. 333]. A boy, aged 6; totally deaf after (cerebro-spinal?) meningitis when about 3 years old; died from pneumonia in measles; the post-mortem examination revealed chronic internal hydrocephalus and adhesions between the spinal membranes. In the vestibule the plate of the stapes was seen to be laterally displaced, and the space produced filled with fibrous tissue; the aperture of the aquæductus vestibuli was filled with fibrous tissue. The membranous semicircular canals were partially destroyed and replaced by fibrous or osseous tissue, which was also the case with the cochlea, in which was also found deposits of calcareous masses and of pigment, and other products of degeneration. *L.*, the aperture of the aquæductus into the vestibule was closed by an osseous mass; the sacculus rotundus was expanded. The membrane of Reissner was also expanded.

LXVIII.—MYGIND, HOLGER, 1892 [214, p. 17]. A boy, aged 9, with only partial deafness on the right side, caused by scarlatinous otitis media in his fourth year; died from purulent meningitis caused by propagation of the inflammation from the middle ear. The tympanic cavity, which was totally devoid of its normal contents, formed, together with the interior of the mastoid process, a large cavity filled on the right side with cholesteatomatous masses, and on the left with fœtid pus; on the right side the cavity described communicated with the cerebral cavity by means of small openings caused by carious destruction; the fenestra rotunda on both sides was closed by an osseous mass. *R.*, all the normal cavities of the labyrinth were present, but filled with cholesteatomateous masses. *L.*, the whole petrous bone formed a solid osseous mass, in which no traces of the normal cavities of the labyrinth were to be seen.

LXIX.—MYGIND, HOLGER, 1893 (not previously published). A man, aged 32; totally deaf from an unknown disease when 6 years old; died from tuberculosis. The membrana tympani was absent; the normal contents of the tympanic cavity were absent; the tympanic cavity was considerably diminished on account of numerous osseous deposits in the walls, especially in the inner wall, where the promontory was replaced by a warty prominence; the fenestra rotunda was closed by an osseous mass; the aditus ad antrum mastoideum closed; and the mastoid process sclerotic. The membranous contents of the labyrinth were absent. *R.*, the fenestra ovalis formed a small irregularly-shaped opening. The cavity of the vestibule was separated from that of the cochlea by an osseous mass, which also occupied the first fourths of the basal turn of the cochlea; the vestibular aperture of the aquæductus vestibuli was closed by a bony mass; the apertures of the semicircular canals being all present, but only forming deep grooves, the canals themselves being entirely missing. The upper part of the modiolus and the partition wall between the last turn and the last but one were absent, the top of the cochlea forming a large cavity. *L.*, the fenestra ovalis was normal. The superior and the posterior semicircular canals were present and normal; the external canal was closed in its middle third. The cochlea communicated by means of a narrow aperture with the vestibule; of the normal cochlear cavity only a portion, corresponding to the first third fourth turn, was present, the remainder forming a cavity of much larger dimensions than that of the right side.

C.—*Cases in which the Origin of Deafness has not been stated.*

LXX.—Reimarus, H. S., 1798 [24, p. 57]. A boy, aged 5; the tympanic cavity was filled with thick mucus. The ossicula auditus were absent. The external semicircular canal was contracted.

LXXI.—Ackermann, T. F., 1805 [27, p. 96]. An adult male, who died from pleurisy; the auditory nerve was exceedingly large and hard, originating from the fourth ventricle without forming the striæ acusticæ; besides other abnormalities at its origin.

LXXII.—Rosenthal, F. C., 1819 [28, p. 12]. An adult male, supposed to have been totally deaf; the membrana tympani was thickened; the tympanic mucous membrane was swollen;

the whole middle ear was filled with a clear fluid. The auditory nerve was very hard. The medulla oblongata was also of abnormal hard consistency.

LXXIII. and LXXIV.—ITARD, 1821 [31, vol. ii., p. 405]. Age and sex unknown; the tympanic cavity was filled with chalky masses.

LXXV. and LXXVI.—ITARD, 1821 [*ibid*]. Age and sex unknown; the mucous membrane of the tympanic cavity was covered with vegetations. There was destruction of the membrana tympani and the ossicles.

LXXVII.—ITARD, 1821 [*ibid*, p. 406]. Age and sex unknown; the tympanic cavity was filled with gelatinous masses, which also occupied the cavities of the labyrinth.

LXXVIII.—ITARD, 1821 [*ibid*]. Age and sex unknown; the patient died of "ataxic" fever. The auditory nerve was of mucous consistence.

LXXIX.—SCHALLGRUBER, 1823 [33, p. 137]. A boy, aged 12. The tympanic cavity was spacious, with uneven walls, especially about the fenestra ovalis; the fenestra rotunda and the promontory were absent; the mastoid process was without any cells and without any communication with the tympanic cavity. The superior semicircular canal was very wide. The cochlea was absent.

LXXX.—IBSEN and MACKEPRANG, 1826 [216, specimens Nos. 12 and 13]. A girl, aged 15, who died from tuberculosis. The aquæductus vestibuli was expanded. In the cochlea the partition wall between the second and the third turn was absent, the top of the cochlea forming a large cavity. The right lamina spiralis was distinctly developed only in the beginning of the first turn. The posterior semicircular canal was visible on the posterior surface of the petrous bone.

LXXXI.—BECK, K. J. (?) or NUEFFER (?), 1827 (?) [36, p. 116, and Badensische Annalen, I. Jahrgang, Heft I., p. 21]. A woman (?), aged 40; the tympanic cavity was filled with fibrous tissue, which massed the ossicula auditus together, and also filled up a portion of the Eustachian tube.

LXXXII.—ILG, 1827 [37, p. 19]. Sex and age not stated. The semicircular canals were filled with osseous tissue.

LXXXIII.—KROMBHOLTZ, 1827 [37, p. 20].—Sex and age not stated; the ossicula auditus were uncommonly small and anchylosed. The walls of the semicircular canals were very thin (as in a fœtus) and partly missing.

LXXXIV.—MACKEPRANG and LARSEN, S. E., 1829 [216, specimens Nos. 18 and 19]. A male, aged 18, who died from tuberculosis. *R.*, the posterior and external semicircular canals were filled with osseous tissue. *L.*, the internal auditory meatus was uncommonly wide.

LXXXV.—IBSEN and MACKEPRANG, 1830 [216, specimens Nos. 26 and 27]. A male, aged 18, who died from scarlet fever. The posterior semicircular canal to its greatest extent was filled with an osseous mass. *L.*, the external orifice of the aquæductus cochleæ was very wide, and situated on the posterior surface of the petrous bone.

LXXXVI.—COCK, EDW., 1832 [45, p. 154]. A child, sex unknown, who died from tuberculosis. Tuberculous inflammation of the tympanic cavity existed. The superior and the posterior semicircular canals were closed in their middle portion. (Only the one side was examined).

LXXXVII.—MÜLLER (I. G. M.?), 1832 (?) [40 p. 166]. A girl, aged 14, who died from "nerve fever." There was asymmetric construction of the cranium, and the auditory nerve was uncommonly thin and weak.

LXXXVIII.—MÜLLER (I. G. M.?), 1832 (?) [40, p. 166]. A boy, aged 10, who died from "inflammatory catarrhal fever" and hydrocephalus. The incus was absent. The auditory nerve was also absent. *L.*, the membrana tympani was ossified; the tympanic cavity being uncommonly large, and filled with pus and attacked by caries. The Eustachian tube was closed.

LXXXIX.—MÜLLER (I. G. M.?), 1832 (?) [40, p. 167]. A girl, aged 14, with very weak intellect; died from "abdominal consumption." The post-mortem examination revealed watery effusion in the cerebral cavities. The ossicles were partly destroyed by caries. *R.*, the membrana tympani was very thin, and the tympanic cavity was filled with caseous matter. *L.*, Caries of the labyrinth was present. Only traces of the auditory nerve were found.

XC.—Bergmann, G. H., 1833 [47, p. 61]. A female adult who died from pleuro-pneumonia. The mucous membrane of the tympanic cavity was sarcomatously swollen, and the cavity was filled with thick mucus. The membranous semicircular canals were absent.

XCI.—Dalrymple, 1834 [45, p. 158]. Sex and age unknown; the aquæductus vestibuli was so wide that it allowed a probe to pass.

XCII.—Cock, Edw., 1834 [45, p. 156]. A child, who died from tuberculosis. Tubercular inflammation of the tympanic cavity existed, with destruction of the membrana tympani. *R.*, the middle portion of the superior and the posterior semicircular canals was wanting. *L.*, the middle portion of the superior and the external canals was wanting. The scala tympani was closed from the tympanic cavity by means of an osseous wall.

XCIII.—Delau, jun., 1834 [41, p. 39]. A boy, age not stated, with deaf-mutes among his relatives; died from an abdominal disease. The stapes was absent.

XCIV.—Wever, F. C., 1834 [42, p. 11]. A man, aged 26, who was not totally deaf; died from tuberculosis. The membrana tympani was thickened; the tympanic cavity being filled by a fibrous mass and the Eustachian tube closed by a similar mass.

XCV.—Thurnam, J., 1835 [44, p. 162]. Sex and age not stated; the membranous contents of the vestibule were absent. *R.*, the membranous semicircular canals were absent, and the external semicircular canal was absent in its middle third. *L.*, calcareous concrements were found in the vestibule. (The absence of the membranous portion of the labyrinth was, perhaps, artificially caused by the dissection).

XCVI.—Cock, Edw., 1835 [45, p. 159]. A child, who died from tuberculosis; the tympanic cavity was uncommonly spacious; the Eustachian tube was widened; the fenestra rotunda was absent; inflammation and suppuration of the tympanic cavity existed on one side. The whole labyrinth was very spacious.

XCVII.—Hyrtl, Jos., 1835 [48, p. 435]. A girl, aged 5; not totally deaf; died from hydrocephalus. The vestibule was very narrow, opening into the fenestra rotunda. The cochlea was substituted by a large cavity, which communicated with the vestibule and with the internal auditory meatus. The auditory nerve was atrophic. *R.*, the plate of the stapes was anchylosed; the posterior limb of the stapes was fixed to the margin of the fenestra ovalis, and the fenestra ovalis formed a narrow slit. Only three apertures of the semicircular canals were present in the vestibule; the posterior crus of the superior semicircular canal and the superior crus of the posterior canal were absent, the two canals forming a tube curved like an **S**; the posterior crus of the external canal was also absent. The petrous bone was abnormally developed. *L.*, the two limbs of the stapes did not meet. All the semicircular canals were contracted.

XCVIII.—HYRTL, JOS., 1836 [*ibid*, p. 437]. An adult; the membrana tympani was very small and very much thickened. The processus Meckelii was ossified. The semicircular canals were contracted and diminished in size. Only two turns of the cochlea were present and the top formed a cavity in which the modiolus was to be seen, but the lamina spiralis was absent. *R.*, the plate of the stapes and the fenestra ovalis were very small; the posterior limb of the stapes did not join to the plate. *L.*, the stapes was absent; the fenestra ovalis was closed by an osseous plate (basis stapedis ?).

XCIX.—COCK, EDW., 1838 [51, p. 294]. A boy, aged 12, who died from meningitis. The tympanic cavity and the mastoid cells were filled with granulations. The cochlea was represented by a large cavity containing on the right side a rudiment of the modiolus and the lamina spiralis. *R.*, the aquæductus vestibuli was very wide. The fenestra rotunda was very small. *L.*, the vestibule was irregularly shaped, extending outwards so as to include the external semicircular canal, which was absent; the posterior canal was wanting; this was also the case with the posterior half of the superior canal. The aquæductus vestibuli was absent. The petrous bone was small and ill-shaped, the meatus auditorius internus forming a narrow slit.

C.—COCK, EDW., 1838 [51, p. 298]. A girl, aged 13, who died from phthisis. Granulations and mucopurulent fluid were found in the middle ear. The scala tympani terminated in a blind extremity after half a turn round the modiolus; the scala vestibuli terminated after one-third of a turn in a large cavity;

the lamina spiralis being deficient. *R.*, the Eustachian tube was very wide. The petrous bone contained numerous cavities which communicated with the tympanic cavity. *L.*, in the vestibule there were only four openings of the semicircular canals, that which is common to the posterior extremity of the superior and the superior extremity of the posterior canal being absent, these two canals forming one tube. The petrous bone was irregularly shaped. The meatus auditorius internus was very narrow. There was no external appearance of the aquæductus vestibuli.

CI.—Cock, Edw., 1838 [51, p. 299]. A boy, aged 11, who died from phthisis. The petrous bone was of enormous size and abnormal hardness. *R.*, the musculus stapedius was absent.

CII.—Mansfeld, 1839 [69, p. 463]. A girl, totally deaf, who died from tuberculosis. The membrana tympani was horizontal; the stapes was deformed; the plate of the stapes being anchylosed; the mastoid process contained only one large cavity; the Eustachian tube was contracted; the tensor tympani was transformed into a caseous mass. The membranous contents of the vestibule and the semicircular canals were absent. The scala tympani opened into the vestibule. The auditory nerve was of hard structure and without distinct fibres.

CIII.—Nuhn, 1841 [57, p. 17]. A man, aged 35, who died from "nerve fever." The membrana tympani was horizontal; the fenestra rotunda was absent. The vestibule was expanded and without any membranous contents. The external semicircular canal was absent; all the membranous canals were absent. The modiolus and the lamina spiralis were absent, the cochlea forming a large cavity without any membranous contents. The auditory nerve was absent up to the fourth ventricle; two small filaments passed from the facial nerve to the vestibule. The internal auditory meatus was contracted; the tractus spiralis was absent. Considerable asymmetry of the cranium existed.

CIV.—Bochdalek, 1842 [60, p. 136]. An idiotic boy, aged 12, with total deafness. Both the aquæducti were absent. Chronic hydrocephalus existed.

CV.—Gherini, Ambrogio, 1848 [71, p. 56]. Sex and age unknown. The fenestra ovalis was absent.

CVI.—GHERINI, AMBROGIO, 1848 [*ibid*]. Sex and age unknown. The auditory nerve was thin.

CVII.—GHERINI, AMBROGIO, 1848 [*ibid*]. Sex and age unknown. The tympanic cavity was very wide. The petrous bone was greatly developed and hard; both the styloid processes were elongated.

CVIII.—GHERINI, AMBROGIO, 1848 [*ibid*]. Sex and age unknown. The ossicles adhered to the roof of the tympanic cavity by an osseous mass. *L.*, the fenestra ovalis was very small and deep.

CIX.—GHERINI, AMBROGIO, 1848 [*ibid*]. Sex and age unknown. The tympanic cavity was very small; the ossicles were very slightly developed. The petrous bone was very small.

CX.—GHERINI, AMBROGIO, 1848 [*ibid*]. Sex and age unknown. The tympanic cavity was very large; the ossicles were anchylosed, the incus being fixed to the posterior wall of the cavity. The promontory was absent.

CXI.—GHERINI, AMBROGIO, 1848 [*ibid*]. Sex and age unknown. The fenestra ovalis was small and deep. The semicircular canals were contracted.

CXII.—GHERINI, AMBROGIO, 1848 [*ibid*]. Sex and age unknown. The Eustachian tube was contracted. *R.*, the tympanic cavity was small; the ossicles were thin; the incus was fixed to the mastoid cells. The inferior two-thirds of the posterior semicircular canal were absent. *L.*, the fenestra rotunda was very small; the promontory was almost entirely absent. There were only four openings of the semicircular canals in the vestibule, the posterior canal being absent, and the superior canal longer than usual.

CXIII.—MEISSNER, C., 1853 [74, p. 163]. Sex and age unknown. Numerous corpora amylacea were present in the auditory nerve and in the floor of the fourth ventricle.

CXIV.—TRIQUET, E. H., 1857 [79, p. 475]. A man, aged 74. *L.*, The stapes had only one extremity. The fenestra rotunda was contracted.

CXV.—GELLÉ, 1858 [83, p. 330]. A man, aged 24, "mute, but not deaf from birth;" died from pulmonary consumption. Partial inflammation of the mucous membrane of the tympanic cavity existed; the articulation between the malleus and the incus was anchylosed; the crura incudis, and the posterior limb of the stapes were fixed to the tympanic wall by means of osseous adhesions.

CXVI.—Helie, 1858 [82, p. 485]. Sex and age unknown. The semicircular canals, and the cochlea were absent. The auditory nerve was thin, consisting of two bundles: an anterior and a posterior, the latter being gelatinous without any appearance of nerve fibres. *R.*, the vestibule was absent. The cochlea was also absent. Instead of the semicircular canals, only a single canal, the position of which corresponds to that of the posterior semicircular canal, existed, which terminated in an aperture on the posterior surface of the petrous bone. *L.*, the fenestra rotunda was closed by an osseous plate. The vestibule was filled with a soft white mass, in which the vestibular nerve terminated.

CXVII.—Helie, 1858 [*ibid*]. Sex and age unknown. The superior semicircular canal was absent; the external canal was very small. The auditory nerve originated with only one root from the corpus restiforme.

CXVIII.—Meyer, H., 1858 [81, p. 551]. An adult, completely deaf, suffering during the latter period of his life from melancholia. There was thickening of the ependyma in all the cavities of the cerebrum and the cerebellum. The striæ acusticæ were absent.

CXIX.—Toynbee, Jos., 1860 [86, p. 403]. A girl, aged 16. *R.*, quantity of otoconia were present in the middle of the superior semicircular canal. (The left ear was not examined).

CXX.—Toynbee, Jos., 1860 [*ibid*]. A young woman, who died from tubercular inflammation of the brain. The membrana tympani was absent; the mucous membrane of the tympanic cavity was red and thick. The semicircular canals contained more otoconia than natural. The basal portion of the scala tympani was filled with an osseous mass, which originated from the lamina spiralis. The petrous bone was intensely hard. *L.*, the lamina spiralis was of deep red colour; blood was effused into both scalæ.

CXXI.—Voltolini, 1861 [89, p. 126]. A woman, aged 17; who died from typhus. The membranous semicircular canals were very much thickened. *R.*, the membranous semicircular canals contained numerous corpuscles (epithelium). *L.*, the sacculi were thickened, and the sacculus hemielipticus was filled with a calcareous mass.

CXXII.—Voltolini, 1861 [89, p. 128]. A male, aged 16, who died from pulmonary consumption. The sacculus hemielipticus was filled with calcareous masses. The external semicircular canal contained masses of otoliths. The middle root of the right auditory nerve was twice as large as the left. *R.*, the sacculi were filled with otoliths. The membranous semicircular canals contained much pigment. The fenestra rotunda was covered with a membrane. The sacculus rotundus was filled with calcareous masses.

CXXIII.—Voltolini, 1864 [92, p. 209]. A boy, aged 14; died from typhus. The posterior semicircular canal was filled with otoliths. The auditory nerve was hard, containing only neurilema. *R.*, atrophy of all the membranous semicircular canals existed; the osseous canals were contracted. The fenestra rotunda was filled with fibrous tissue.

CXXIV.—Voltolini, 1864 [92, p. 212]. A male, aged 16; who died from pulmonary tuberculosis. The membrana tympani was horizontal; the ossicles were anchylosed. The auditory nerve was firm and tough; no nerve-tubes were present. *R.*, otoliths existed in the basal portions of the cochlea. *L.*, the membrana tympanica secundaria was thickened, and gelatinous. The sacculi, the ampullæ, and the cochlea contained pigment.

CXXV.—Voltolini, 1864 [92, p. 217]. A man, aged 20; who died from typhus. The auditory nerve was very hard, without nerve-tubes. *R.*, the tympanic cavity was filled with blood and pus. (The membranous labyrinth was not examined).

CXXVI.—Voltolini, 1867 [92, p. 218]. A male, aged 17; who died from tuberculosis of the lungs. The membrana tympani was destroyed. The sacculi, the membranous semicircular canals, and the membranous contents of the cochlea were thickened, and their normal structure undistinguishable. The auditory nerve was hard, with very few nerve-tubes. *R.*, the stapes was anchylosed. The superior and posterior semicircular canals were partly closed by osseous substance.

CXXVII.—Moos, S., 1873 [111, p. 199]. An individual, aged 64, who died from heart-disease. All the ossicles were anchylosed. The vestibule was contracted; the aperture of the cochlea was the same; the sacculi contained calcareous concrements. The cavities of the semicircular canals and the cochlea, were diminished in size. The vagina of the auditory nerve contained calcareous concrements. *R.*, exostosis of the floor of the tympanic cavity existed. The fenestra rotunda was closed with osseous substance.

CXXVIII.—Luys, I., 1875 [115, p. 318]. A boy, aged 14; who died from tubercular peritonitis. Atrophy of the cortical substance of the posterior convolutions of the brain existed; hyperplasia of the neuroglia of the posterior part of the tractus opticus was found with thickening of the walls of the third ventricle; and serous infiltration of the source of origin of the auditory nerve. (The ears were probably not examined).

CXXIX.—Moos, S., and Steinbrügge, H., 1882 [152, p. 236]. A man, aged 35, who died from tuberculosis of the lungs. The crus longum incudis was fixed to the labyrinthal wall; pseudo-ligaments were present in both fenestræ. The vestibule was absent; in its place a small cavity existed filled with connective tissue and fatty globules. The semicircular canals were absent. The cochlea was absent. The auditory nerve was partly atrophied. *R.*, the entrance to the fenestra rotunda faced anteriorly. A short canal, corresponding to the external semicircular canal, was present. The cavity of the cochlea was substituted by a small canal filled with fatty globules. *L.*, the membrana tympani was perforated.

CXXX.—Moos, S., and Steinbrügge, H., 1884 [160, p. 247]. A man, aged 50, who died from tuberculosis. The membrana tympani was perforated. Colloid corpuscles were present in the nervous epithelium of the utriculi. *R.*, adhesions existed between the membrana tympani and the promontory; adhesions about the stapes and the tensor tympani were also found. The nerves in the lamina spiralis of the first two turns were wanting; the majority of the ganglion cells of the canal of Rosenthal were absent, and there were fibrous adhesions in the scala tympani. The organ of Corti, and the membrana tectoria were missing. Colloid and hyaline corpuscles existed in several parts of the labyrinth. *R.*, adhesions and pus were found about the fenestra rotunda. *L.*, the nervous epithelium and the nerves of the sacculus were wanting. The scalæ were filled with a granular mass.

CXXXI.—Moos, S., and Steinbrügge, H., 1884 [160, p. 250]. The case was that of an individual, aged 30. The mastoid process was sclerotic. Hyaline corpuscles existed in the epithelium of the utriculus. The ductus cochlearis was filled with caseous masses; the nerves of the lamina spiralis were wanting in the first turn. *R.*, calcareous deposits existed in the membrana tympani, and adhesions between the malleus and the incus. *L.*, pseudo-ligaments were found about the posterior limb of the stapes, and the tensor tympani. In the sacculus there was a conglomeration of cells; the utriculus adhered to the plate of the stapes; the nervous epithelium of the maculæ was wanting, and was replaced by hyaline corpuscles. The lamina spiralis ossea adhered to the wall of the scalæ in the basal part of the cochlea; in the upper part fibrous adhesions existed in the scala tympani.

CXXXII.—Moos, S., and Steinbrügge, H., 1886 [169, p. 123]. A patient, sex and age unknown; died of phthisis. The mastoid process was sclerotic; there was hyperostosis of the external auditory meatus. The periosteum of the vestibule was considerably thickened with the formation of several small cavities, which were partially filled by round cells and caseous masses. In the cochlea there were periosteal inflammatory products, and partial destruction of the nervous apparatus. *R.*, the membrana tympani was perforated; the tympanic cavity was narrowed by hyperostosis; there was pus in the fenestra ovalis. *L.*, the membrana tympani was almost completely destroyed; the caput mallei was carious: the tympanic cavity, and the antrum mastoideum were filled with pus; the crura stapedis were absent.

CXXXIII.—Moos, S., and Steinbrügge, H., 1886 [169, p. 126]. A patient, sex and age unknown; died from phthisis. Cholesteatomatous formations in the tympanic cavity, and the antrum mastoideum; the mastoid process was sclerotic, the ossicles and the fenestra ovalis were absent. The periosteum of the vestibule was very much thickened, its cavity being reduced to a narrow slit, which was filled with connective and nervous tissue. *R.*, the membrana tympani was absent, and so were the semicircular canals, in their place was a small cavity containing epithelium and colloid corpuscles. The cochlea was absent. *L.*, the membrana tympani was replaced by cicatriciel tissue. Only one of the semicircular canals was indicated; it was filled with periosteal formations; in the place of the two superior ampullæ were two larger cavities, filled with connective tissue and colloid corpuscles. The cochlea was only partly present, and was filled with fibrous bands and new formation of osseous tissue.

CXXXIV.—Gradenigo, G., 1887 [175, p. 48]. A girl, aged 15, with total deafness; died from pulmonary consumption. The membrana tympanica secundaria was destroyed. The membranous contents of the vestibule were also destroyed, and its cavity was narrowed by osseous deposits. The semicircular canals were absent. The membranous contents of the cochlea were destroyed, and its interior was filled to its greatest extent with new formations of osseous tissue, especially on the left side. *R.*, the basis stapedis was altered in shape and position and surrounded by fibrous tissue. *L.*, the membrana tympani was destroyed; suppuration of the middle ear existed; the malleus and the incus were absent; only remnants of the basis stapedis were present; the articulation between the stapes and the fenestra ovalis was destroyed; the niche of the fenestra ovalis and the fenestra rotunda were filled with fibrous tissue. In the cochlea were found only traces of the membrana basilaris.

CXXXV.—Habermann, J., 1887 [190, p. 376]. A woman, aged 50; died from cancer of the stomach. *R.*, the membrana tympani was almost entirely absent; the manubrium mallei and the crus longum incudis were absent; the tympanic cavity was filled with pus; the niche of the fenestra ovalis was filled with fibrous tissue; the mastoid process was sclerotic, and its antrum filled with pus. Thickening of the vaginæ of the nerves existed at the maculæ and of the periosteum of the vestibule. In the cochlea there was atrophy and partial absence of the nerves and the ganglion cells of the two inferior turns; the organ of Corti was absent; in the scala tympani were fibrous bands and beams of osseous tissue; large quantities of pigment were present all over the cochlea. The branches of the auditory nerve to the vestibule and to the cochlea were thinner than normal. (The left side was not examined).

CXXXVI.—Gellé, 1888 [212 p. 231]. A patient, whose sex and age are unknown. There was anchylosis of the stapes, atrophy of the nervous elements of the labyrinth, and atrophy of the auditory nerve.

CXXXVII.—Scheibe, A., 1890 [199, p. 12]. A man, age 47; died from pulmonary consumption. Adhesions existed in the tympanic cavity. In the sacculus numerous microscopical anomalies of formation were discovered; also atrophy of the supplying nerves. Colloid corpuscles were found in the crista acustica of the posterior and external semicircular canals, with atrophy of the corresponding nerves. Numerous microscopical anomalies of formation of the membranous contents of the cochlea existed, along with atrophy of the cochlear nerve. There was also atrophy of the ramification of the ramus Retzii of the auditory nerve. Cysts were found in the cerebrum.

CXXXVIII.—Draispul, 1890 [202, p. 69]. A woman, aged 40; the capitulum and the posterior limb of the stapes was fixed to thé posterior superior margin of the fenestra ovalis; the fenestra being closed by an osseous mass, which covered the promontory.

CXXXIX.—Mygind, Holger, 1892 [not previously published]. A woman, aged 20; totally deaf and slightly imbecile, having had, in her 8th year, symptoms of (hereditary ?) syphilis; died from tuberculosis. The mastoid process was very little developed, and presented few pneumatic cells. The whole of the membranous labyrinth was absent. Of the normal cavity of the cochlea only the greatest portion of the first turn was distinctly observable, the remaining part forming a large cavity; the aquæductus cochleæ being closed almost through its whole length. The tractus spiralis foraminulentus was absent, being replaced by a large aperture leading to the cavity of the first turn; this aperture was filled with a fibrous plate in which the cochlear nerve ended. The posterior semicircular canal was distinctly seen on account of absence of osseous tissue on the corresponding portion of the posterior surface of the petrous bone.

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